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A MONTHLY MAGAZINE DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR

Vol. XI AUGUST, 1906 No. 6

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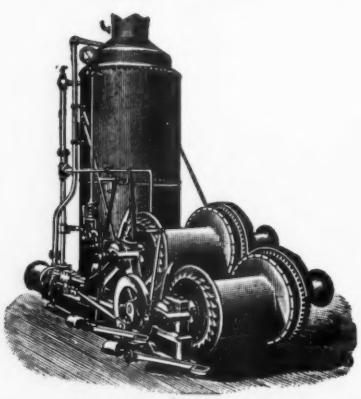

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AUGUST, 1906.

HOW HORIZONTAL RUNS AFFECT THE AIR LIFT.

WRITTEN FOR COMPRESSED AIR BY HERBERT T. ABRAMS, MEM. AM. SOC. M. E.

In the application of compressed air for pumping, more particularly in connection with the operation of deep wells, the air lift system finds its broadest field, and in this particular work has advanced year by year in public favor, as is evidenced by the number of new installations, both private and municipal.

Briefly, the reasons for the popularity of this method of pumping in water, oil and salt well propositions are the advantages claimed by the trade: Absence of working parts in the well, low maintenance charges, assured maximum yield from any well, and the central plant pumping any number of scattered wells.

All of these claims are acknowledged generally, in fact are indisputable, their being but one reservation in the mind of the engineer and that concerns the question of economy, meaning power consumption alone, without any reference to final savings made through the installation of an economical air lift system.

We have to deal in this article with one of the limitations of the air lift system, and as far as the writer knows, one in regard to which little information is at hand.

It is frequently necessary to deliver water to an elevated tank or reservoir at some considerable height above and distance from the well, in which event it has generally been considered inefficient to make the lift at the well force the water horizontally and end with a lift to a tank, but to just what extent the problem was affected by these conditions has always been a matter of guess work. Confident, however, that serious disadvantage attached to forcing water from a well a long distance, the practice has been, wherever possible, to avoid doing so by substituting either:—

1. Vertical lift at the well high enough to flow the water by gravity to the desired point, employing standpipes (Fig. 1); or,

2. Raise the water to a surface reservoir or cistern near the well and deliver the water above ground by means of an ordinary pressure pump, or a pneumatic displacement pump, submerged directly in the receiving tank or reservoir, thus through a combination of the air lift and pneumatic pump rounding out the whole operation as a complete compressed air system of pumping.

Either of the above methods are preferable to the continued use of the air lift system under such conditions as we are about to consider, but circumstances often prohibit these alternatives or the question of first cost may demand a figure based on making the lift direct with the air lift, and to meet such it is necessary to know what this additional work amounts to.

FIG. 1.

The writer recently had occasion to make several experiments along this line in a well 8″ diameter by 800 feet deep, involving lifts in the well of from 13 to 30 feet horizontal runs of 200 and 600 feet with a terminal lift of 50 feet. Standard air lift apparatus was used, which included an Ingersoll-Rand 10 & 10¼x12 Class "A" compressor, air receiver, and the usual piping, and the derrick (Fig. 2) for obtaining the desired lift above surface.

As usual in all air lift experiments, the factors of submergence and velocity of flow figured largely, and a number of tests were made in the endeavor to locate the best points.

For example, in the 200 foot horizontal run it was found that a submergence of 40% required two and one-half times the volume of free air per gallon of water pumped, compared with 60% submergence, and in the 600 foot

trial two and eight-tenths times as much air under same relative submergences.

Curve (A), 60% submergence, gives the best performance for a run of 607 feet, showing that to deliver a foot-gallon of water required .0111 cu. ft. of free air, and best rate of discharge to be seven gallons water per minute per square inch area of discharge pipe.

The 207 foot horizontal, 60% submergence, took .0085 cu. ft. per foot-gallon with 8.9 gallons water per minute per square inch area of discharge pipe.

To illustrate the effect of submergence Curve (B) is introduced indicating the results with

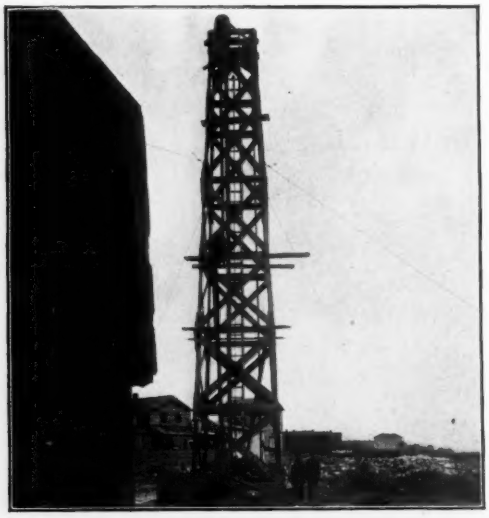


FIG. 2.

40% submergence, 200 foot horizontal run, these conditions, as will be noted giving .0197 cu. ft. free air per foot-gallon as being required, and the best rate of discharge 4.2 gallons water per minute per square inch area of discharge pipe.

It is especially noticeable that increasing the volume of air supplied had little effect upon the quantity of water delivered, in fact the curves show very graphically serious losses following any tendency to force the output.

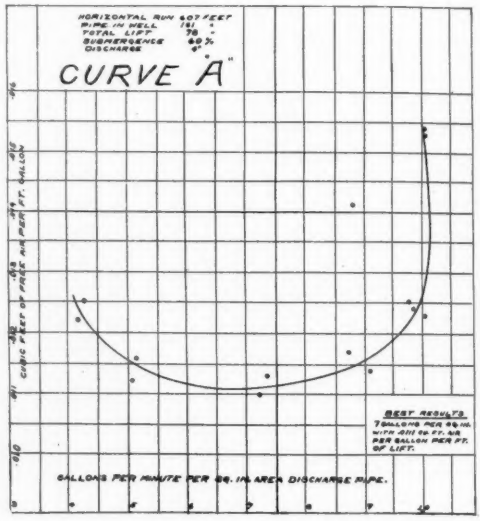
The following tables have been prepared from the tests made, based on average results, and are considered to be safe and conservative:

Cubic feet of free air and gallons per minute per square inch area of discharge pipe for lifts of 13 to 30 ft. at well, horizontal run of 200 feet, subsequent lift of 50 feet.

Submergence per cent.	Cubic feet Free Air per foot gallon	Gallons per minute per sq. in.
40	.0231	4
45	.0176	5.2
50	.0138	6.4
55	.011	7.6
60	.0094	9

Cubic feet of free air and gallons per minute per square inch area of discharge pipe for lifts of 13 to 30 feet at well, horizontal run of 600 feet, subsequent lift of 50 feet.

Submergence per cent.	Cubic feet Free Air per foot gallon	Gallons per minute per sq. in.
40	.0352	3.6
45	.0264	5
50	.021	6
55	.016	7
60	.0127	8



Having these figures in view it may be profitable to make a single comparison of air lift vs. combined air lift and pneumatic displacement pump.

Disregarding the tables and referring again to the curve (A) 60% submergence, 607 feet horizontal run, we observe the factor at the best point is .0111 cubic feet per foot-gallon.

The water discharged being approximately 90 gallons per minute and the lift 78 feet we have:—

90 gals. $\times$ 78 ft. $\times$ .0111 = 78 cu. ft.

The working air pressure being 52 lbs. we may calculate the horse-power from the common tables in use and the result is 10.9 H. P.

Before proceeding, and in justice to the air lift system, it will be fair to note that if this

were a straight lift of 78 feet the air required would have been 90 gals. × 78 ft. × .0062 = 43.6 cu. ft., representing 6 H. P.

Now taking up the combination of air lift and displacement pump to meet the actual conditions we have:—

1st. A vertical lift of 28 ft. for the air lift system.

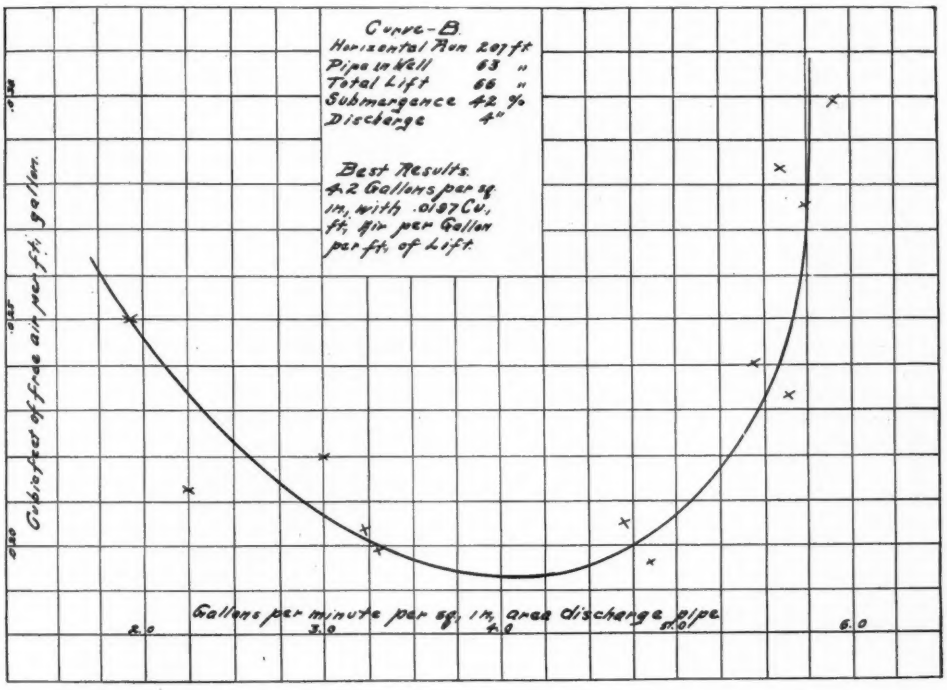
2nd. A horizontal run of 607 feet and a terminal lift of 50 ft. for the displacement pump.

The free air required for the vertical lift of 28 feet with the air lift is:—

90 gals. × 28 ft. × .0122 = 31 cu. ft.

be added for clearance and other losses, making 35 cu. ft. Adding the figures for the air lift 31 cu. ft. and displacement pump 35 cu. ft., we have a total of 66 cu. ft. at 25 lbs. pressure, representing 5.6 H. P.

As the horse power required for this work under the air lift system alone was found to be 10.9 H. P. and for the air lift and displacement pump 5.6 H. P. there is a saving of 5.3 H. P. in favor of the latter arrangement under the stated conditions, from which we must conclude that good practice will favor the combination wherever it is feasible to employ it.



The compressed air needed for the displacement pump is a volume equal to the amount of water displaced at a pressure due to the head. The 90 gals. of water to be pumped equals 12 cu. ft. and the pressure required will be approximately 25 lbs., due to the head of 50 ft., plus friction. Reduced to free air,

$$12 \times \frac{25+15}{15} = 32 \text{ cu. ft.}$$

Ten per cent. should

THE RETURN-AIR AND PUMPING SYSTEM.

BY FRANK RICHARDS.

The use of compressed air direct for forcing water to any elevation is one of those natural and self-evident propositions which requires no suggesting to anybody in the first place and no urging to at least make a trial of it. Many by different devices and arrange-

ments have taken up and applied this idea, and all have soon found, as a little thought would have assured them without trial, that though the operation might be one of the simplest and the device employed the cheapest the results were after all quite wastefully secured. The raising of water by direct displacement by compressed air, volume for volume, is not a cheap operation, and yet the convenience and reliability of it leads not only to its employment but also to its retention for the service in many cases.

The objection to the system is that when the compressed air has done its work of expelling the water from the operating chamber it is then released with much of its potential energy unused. There are additional losses in the way of filling large clearance spaces and, in many cases, in the uncompensated dissipation of surplus original pressure above that required to balance the water head. The use of twin displacement chambers, required to make the action alternate and automatic, and practically continuous, does not effect the result as far as economy is concerned, indeed often making the waste of air still greater by entailing larger clearance spaces to be filled.

And now comes along another device which has been a long time coming, but which when it comes is at once recognized as the thing. The principle of it is at once self-evident, and the perfect success of it when applied requires no practical demonstration to provoke the familiar exclamation: "Why didn't somebody think of that long ago?"

This is the RETURN-AIR System of Compressed Air Pumping. It is a revolutionary invention and, its field of employment being so extensive, it is also one of the greatest importance.

Its operation, in contrast to that of the too familiar single pipe, direct displacement pump, is that while the old pump will take all that is given to it for raising and delivering a given weight of water and will return absolutely nothing, this new device will take only what exactly pays for the work done, and then *it returns all the change.*

The whole thing can be explained to any one with his eyes shut and without referring to any diagram. It must be premised that this is not a little cheap and handy device to go, for instance, wherever a steam pump might be employed, and to do the same work, but is intended for large and permanent installations, each plant being complete in itself and doing no other work.

There is first of all an air compressor whose entire business it is to operate the pump. There is nothing special about the compressor except that it is in most cases a single stage machine, and it, of course, may be driven by any available power.

The pump part consists of two similar chambers to be alternately filled and emptied. These are submerged in the water to be pumped, or at least located near and below the lowest working level of it, so that the water will always be able to flow into either chamber by gravity. The compressed air is conveyed to the pump by pipes direct from the compressor to each chamber, and each pipe also leads the air, after its work of water expulsion is done, back to the intake of the compressor. The same air is thus used over and over again, provision being made for replacing the little that may be lost by leakage or by absorption in the water. The valve arrangements will be sufficiently evident from a description of the operation.

We assume the pump is actually at work, that one of the chambers is full of water, with air of sufficient pressure being admitted at the top of the chamber, exerting its pressure upon the water and driving the water through a check valve and up a pipe to the point of delivery. So far the operation is precisely the same as with any displacement pump, and when the water is all, or nearly all, driven out, the chamber is then full of air at the highest pressure. The regular operation by the old way would be to now close the communication with the compressor and to open another to the atmosphere, allowing the air to expand down to normal atmospheric pressure, the surplus escaping without doing any more work. Water is then allowed to flow in to fill the chamber again, which drives out the rest of the air, and this chamberful of water is driven out and up by the compressed air as before, and so on.

With the return-air system, however, the air is not let off so easily, but is retained to do a lot more work. The air is discharged from the water chamber and up the air pipe, which by the action of the switch is now in connection with the intake of the compressor cylinder, and whatever pressure this air may have is thus always being exerted upon the intake side of the compressing piston, and the pres-

sure upon this side overcomes an equal amount of pressure upon the compressing side of the piston, or deducts just so much from the total power required to drive the piston and to do the work of compression.

Using the air in this way, its entire expansive force is retained on the credit side of the system. Expansion continues until the air pressure is lower than that of the water which is waiting to enter, the difference of pressure depending upon the speed with which the system is being driven, and then the water enters and drives the air into the compressor intake at this pressure instead of letting it expand further, and thus raises the total mean effective pressure at the back of the piston above that which would have resulted from the expansion alone.

Each return pipe installation is an individuality, with special conditions to be satisfied and calling for special sizes and capacities, both relative and actual. The system is advantageously applicable to both extremes of the possible range of practical requirements, and to all between.

Where the lift is practically constant, as in raising water from a lake or river to a water works reservoir, the compressor and the pump may be so related as to secure all the expansive force of the air with comparatively little of the follow-up pressure, if we may so call it, from the water, but still with the highest possible ultimate efficiency and economy. In any case as the compressor is in immediate touch with its work, there is no loss from overcompression, or from compressing above the actual requirement, as is often the case with the direct displacement systems.

If the return-air system is employed where the level of the water supply has considerable range, as in emptying a large, deep shaft of a mine, the follow-up pressure of the water in refilling the operating chamber will vary constantly with the level, and at all levels will approximately adjust the work of the compressor according to the actual water lift at the time; and although the water must always be lifted under full head, and with the full pressure for expelling the air, the compressing of the air to that pressure will require little or much power according as the return, or intake, pressure at the compressor may be much or little, corresponding to the height of the water supply. With the direct displacement, and no return of the air, there would be none of this compensation either from the re-expansion of the air or from the follow-up pressure of the incoming water, and all the water lifted, whether the level of the supply was high or low, would require the maximum and entirely uncompensated pressure to raise it.

There was an actual case where it was necessary to provide and to have constantly ready the means of emptying a shaft of considerable area more than 300 feet deep and normally full of water, with a tunnel at the bottom of the shaft also to be emptied. This will be at once recognized as a problem easy enough of solution, in a way, but not so simple when speed and economy were to be considered. There was actually installed for this work a hoisting engine and a large cylindrical bucket, say 4 feet in diameter and 12 feet long, to be successively filled and hoisted and emptied. This might strike one as a rather primitive arrangement, but it had at least the merit of using the power with reasonable economy. The varying height did not at all affect the weight of the bucket of water, and the power consumed was therefore always directly as the height, and with engines showing good steam economy the arrangement was not wasteful of power. The bucket arrangement was actually used for emptying the shaft and tunnel once and it worked all right; but nevertheless it has been superseded by the Return Air system. This has been installed because it could show good power economy and could do the required work in much less time, which was the all important consideration.

The shaft here spoken of is shaft 25 of the New Croton Aqueduct, and the tunnel is the portion of the aqueduct which crosses under the Harlem River, near Washington Bridge, New York City.

In our sketch of the operation of the return-air system we have spoken only of the action in one operating chamber. It is understood, of course, that there are two similar chambers operated alternately, one filling while the other is emptying, so that the lift is practically constant. The switch for reversing the connections of the two pipes is operated in different ways according to the work. For a straight, steady waterworks job the switch may be operated mechanically, tripping one way or the other for each given number of revolutions

of the compressor, or it may be operated automatically by the fluctuating level of the water supply, and it may also always be operated by hand.

The Return-Air system is adapted to and is in actual use for all kinds of pumping. It seems to decline no job which is possible by any system and it works for the lowest air output. It is especially successful in many lines which are not permissible to the formal mechanical devices. It pumps, for instance, water which is so charged with solid matter that it can only be called semi-liquid. It is in some cases regularly employed for conveying the solids so contained, as sand or marl, the mixture when raised going to settling tanks where the water is allowed to flow off and the solid can then be shoveled and conveyed wherever required.

A list of actual installations of thc Return-Air Pumping System shows already a wide and interesting range of successful employment. What the device needs most of all is to be better known.

AIR-LIFT PUMPING.*

BY GUSTAV C. H. FRIEDRICH.

This paper, the last of a series commenced some time ago, will consist of a description of a well recently tested, and some data compiled in a convenient form for the use of those contemplating the construction of an air lift. This information I have gathered from various sources, and it has been demonstrated in practice. The tables will be found convenient.

Several things important to success and economy must be taken into consideration in the installation of this system of raising water. The first is a sufficient supply of water, as this method is not suitable where a small supply only is obtained. The tables should be consulted and the well then permanently piped for the size pipe given in the proper column corresponding to the amount of water furnished by the well. If one well does not furnish the amount of water required, more wells can be put down, and the air furnished by one compressor, located in any convenient place, as has been previously suggested.

Economical compression of air is also essential. Air is a gas subject to rapid expansion under the rise of temperature, and, as we are dealing with volumes at atmospheric pressure, it is necessary that the air should be taken into the compressor at as low a temperature as possible. By the use of a good compressor, economical results can be obtained.

The well lately tested is 300 feet deep, the water being elevated above the surface of the ground 85 feet. When the well is being worked the water level is 44 feet from the surface of the ground, making a total life of $44+85=129$ feet. The water pipe extended down 297 feet, or within 3 feet of the bottom of the well, and from the bottom of the water pipe to the bottom of the air pipe is 5 feet, making a total of $5+85=377$ feet, making a total length of the water pipe, from the point at which air enters to the point of discharge, 377 feet. Subtracting the lift, 129 feet, from 377, gives 248 feet submersion.

Pipes were arranged in the following manner; from the surface of the ground to the end of the pipe extending into the well, the water pipe is 3.5 inches in diameter; to the upper end of this pipe a Y is fastened. Into the center, a 1.25 inch air pipe is put, extending within 5 feet of the bottom of the water pipe. From the side outlet of the Y, a 3-inch pipe extends to the point of discharge. This arrangement would be the same as a 3-inch lift. The well is 8 inches in diameter; the water delivered is 82.5 gallons a minute, or 11 cubic feet; the air used to raise this amount was 81.81 cubic feet of free air, being equal to a little more than 7.43 cubic feet of air to 1 cubic foot of water.

Air pressure was 107 pounds, with a loss of 9 per cent. in its compression. The horsepower required to compress the amount of air used in the operation of this system was 12.134. A percentage of the efficiency of the lift obtained by different submergence will be seen by table I.

Table II shows the size of the well tube, water and air pipes, corresponding to the given quantity of water delivered. These figures

TABLE I. SUBMERGENCE AND EFFICIENCY.

Submergence, Per cent. of length of Water Pipe	Efficiency, Per cent.
60	50
50	40
40	30
33	25
30	22

*Presented before the Ohio Society of Mechanical, Electrical and Steam Engineers.

have been exceeded by very productive wells, but will often be found too large.

There being 7.5 gallons of water in 1 cubic foot, this number must be used to convert gallons into cubic feet. Table III gives us the ratio of volume of air to water, the submersion air pressure, cubic feet of free air per gallon of water, and the horsepower required for lifting.

Remarks: Special submergence should be used where there is a long horizontal discharge or a great number of turns in the discharge

TABLE II. CAPACITY AND PIPE SIZES.

Size of Well in inches	Water Pipe in inches	Air Pipe in inches	Gals. Water per Min.
4	1½	¾	25
4½	2	1	50
5	2½	1	75
6	3	1¼	100
7	3½	1½	150
8	4	1½	200
9	5	2	300
10	6	2	450

pipe, as shown in the fourth and sixth columns of Table III.

In concluding this paper, I wish to say that for some wells which accumulate foreign matter and sand in the bottom, it is a good idea to put a gate valve in the discharge pipe in some convenient location where it can be easily reached. This valve should be closed about once a month and the air pumped up and allowed to blow out all dirt, slime or gravel which has accumulated therein. This will assist in maintaining the efficiency of the well, as any accumulation will retard the flow of water. When a well is blown out or reversed, where the air pressure is high, the water and accumulations are blown out with great force, and it will be necessary to protect objects within 10 or 15 feet of the well from possible injury.

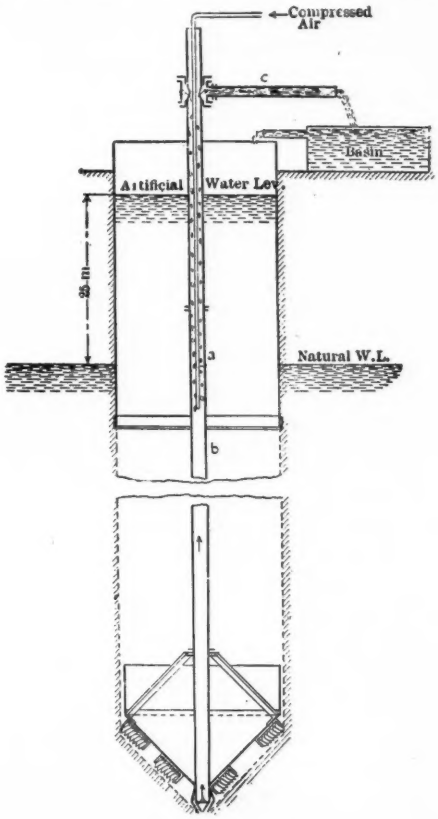
TABLE III. LIFT, SUBMERGENCE AND AIR NEED FOR AIR-LIFT PUMPING.

Lift in feet	Volume of air to 1 foot of water	Subm. equals 60 per cent. total water pipe, ft.	Submergence for special lift, ft.	Air pressure submergence 60 per cent., lbs.	Air Press for sp'l lift submergence 60 per cent., lbs.	Cu. ft free air per gal. per min.	H. P. per gal. per min.
25	2	38	50	17	20	0.3	0.0184
50	3	75	100	33	44	0.4	0.0426
75	4.5	113	150	49	65	0.6	0.0828
100	6	150	200	65	87	0.8	0.1320
125	7.5	188	250	82	109	1.0	0.1910
150	9	225	300	98	120	1.2	0.2544
175	10.5	263	350	115	152	1.4	0.3150
200	12	300	400	130	173	1.4	0.3808

THE HONIGMANN METHOD OF SHAFT SINKING.*

BY ADOLF E. HARTMANN.

Coal mining has been carried on in western Germany for several centuries, and as a result, all the coal deposits near the surface, when geological conditions were favorable, were soon worked out. Only deep-lying seams, or those which could not be opened on account of the thickness of the overlying quicksand, remained. The quicksand in this region



HONIGMANN METHOD.

varies from a few feet to 600 ft.; consequently the problem is to sink shafts through this unstable stratum. Three methods are now successfully employed. They are as follows: 1.

*Engineering and Mining Journal.

The Sassenberg-Clermont method. 2. The Poetsch freezing method. 3. The Honigmann method.

The first two methods are well known. The third has not been used much outside the German coalfields, although it has proved efficient.

The Honigmann method differs from other sinking methods in the respect that no casing is built until the shaft has been completely sunk through the sand to the solid rock formation. To prevent caving in, Honigmann proceeds as follows:

1. The water-level in the shaft is raised to a certain height above the natural water-level in the quicksand outside the shaft.

2. The specific gravity of the water column in the shaft is increased to about 1.2 by mixing clay with the water. By this means a pressure is obtained, which forces the clay contained in the water into the shaft walls, making a more solid mass of the quicksand. The increasing pressure of the quicksand toward the inside of the shaft is held in equilibrium.

The sludge loosened by the shaft percussion-drill is conveyed to the surface by means of a continuous water flow, rising through the hollow cylindrical drill-rod as shown in Fig. 1. A small gas pipe *a* extends into the drill-rod for a short distance, and through this pipe compressed air is forced, which bubbles into the drill-rod *b*, thereby making the water column in *b* lighter than that in the shaft. As a result the water rises into *b* from the bottom of the shaft, as indicated by arrows in the illustration.

The water and sludge flow through the pipe *c* into a basin, where the sludge is allowed to settle while the separated water flows back into shaft. The velocity of the rising water *b* can be increased by forcing more compressed air through the pipe *a*. Clay is mixed in the basin with the water returning to the shaft in order to keep the water in the shaft at the necessary specific gravity.

When the shaft has been sunk through the quicksand, and has reached solid ground, a casing is built in the usual way by means of iron tubing. In passing through the quicksand constant care has to be exercised to keep the artificial water-level and specific gravity of the water up to the pre-determined standards in order to prevent a caving in of the shaft.

Seven shafts, varying from 12 ft. to 18 ft. in diameter, have been sunk recently in western Germany by the Honigmann method, without any noteworthy accidents. Most of these shafts passed through quicksand up to 600 ft. in depth.

RELATIVE MERITS OF LARGE AND SMALL DRILLING MACHINES.*

BY FREDERICK T. WILLIAMS.

The purpose of this paper is to discuss the relative merits of the large 3⅛-in. machine and the small 2¼-in. tappet machine in driving development-headings; although the data were obtained from cross-cut headings alone, experience has shown that the results are equally true in drifting, raising and winzing.

Recently we drove two parallel cross-cuts through the same formation, using a 3⅛-in. machine at the breast of one cross-cut, and a 2¼-in. machine of the same make at the breast of the other. The results of this work afforded an ideal comparison, since in both cases the headings were advanced through rock practically of the same hardness and breaking-properties; the amount of sludging was equal, and there was no difference in the condition of the steel or the machines, in the air-pressure or in the experience of the operating-crews.

Some operators in the Cripple Creek district contend that there is ground which cannot be handled with the small machine, the holes being too small to contain enough powder to pull the ground, etc. The results obtained in working the property of the Portland Gold Mining Co., however, show that the ground worked by them does not fall in this class. During a period of two years there have been driven, with the small machine, 4 miles and 308 ft. of development-headings, through a diversity of ground, including Pike's Peak granite (a coarsely porphyritic type of granite), highly indurated, andesitic or phonolytic breccia, true massive andesite, trachytic phonolyte, tuffas, and along dikes of decomposed basalt and hard phonolyte; in every instance a satisfactory record was made.

The headings here described were driven through highly indurated, andesitic breccia, having a hardness of from 5.2 to 7.2 and a sp.gr. of from 2.2 to 2.8. The action of the

* A paper read before the American Institute of Mining Engineers.

breccia under the drill was not materially different from that of ordinary red granite. The breccia was not as free-drilling as granite, and sludge accumulated very rapidly after a shallow depth of hole had been gained, but it broke better than granite.

Aside from the usual work of setting-up, drilling, and loading, the machine men or helpers mucked back, cleaning the floor of muck 3 or 4 ft. back from the breast in order to position the column properly. If the "lifters" acted properly at the previous firing, the muck was fairly well thrown back from the breast; but if either missed fire or were exploded before the other holes, considerable muck was left at the breast which required much additional labor. The usual time needed to muck back was 1.25 hour, but this varied considerably. Flat steel 48x96x3/8-in. sheets, were used, from which to shovel the material. These were placed in position 3 or 4 ft. back from the breast by the trammer just before going off shift. The ground broke fine enough to require little or no sledging. A cubic foot of breccia in place will average 154 lbs. in weight as compared with 90 lbs. on the muck-pile, giving an average of 42 per cent. of void space. All the waste was trammed to the shaft 800 ft. distant, and hoisted to the surface. No timber was used in either heading.

The following summary of the results obtained by using both large and small machines has been prepared from the data given in Tables I and II. Labor is the largest individual item. The wages of machine men were $4 per shift, and the addition of the items given under the several heads of Table I shows the total cost of labor performed in each heading. The cost of operating the machines per shift was $3.70 for the large machine and $1.85 for the small machine; these figures, which vary from month to month, include the cost of everything connected with the operation of the machines: engineer's wages, blacksmith expenses, new steel, repairs to the machines, cost and repair of air-lines, etc. The cost of labor, per foot driven, by the large machine was $3.45, and by small machine $2.56.

The cost of explosives, a detailed report of which is given in Table II, shows that the 40 per cent. dynamite costs $0.127 per lb., the fuse, $0.0035 per ft.; and the caps, $0.007 each.

These figures, which include freight, unloading, wages of the powder man, and one-third of the wages of the store-keeper, represent the entire cost of the material, as laid down at the station for the machine men. All fuse burned was in 7-ft. lengths. The number of feet of fuse burned and the number of caps used per foot are practically the same; but the cost of dynamite is $0.78 less per foot in the heading driven by the small machine than in that of the large machine.

The best record for a shift's run, made by the large machine, was 4.08 ft., as compared with 2.96 ft. for the small machine. In drilling these rounds it was found that the large machine had made 3109.56 cu. in. of hole, and the small machine 971.10 cu. in. Comparing these figures with the cubic feet of ground pulled, 1 cu. in. of hole drilled by the large machine broke 0.053 cu ft. of breast, while the small machine gave 0.097 cu. ft. This comparison shows that too much work was done by the

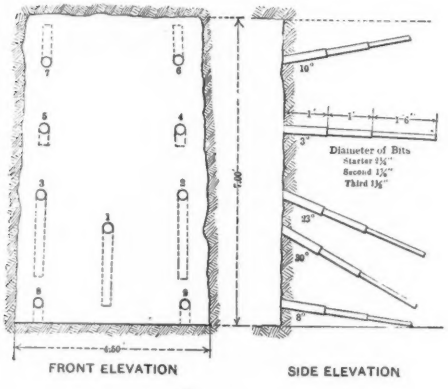


FIG. 1.

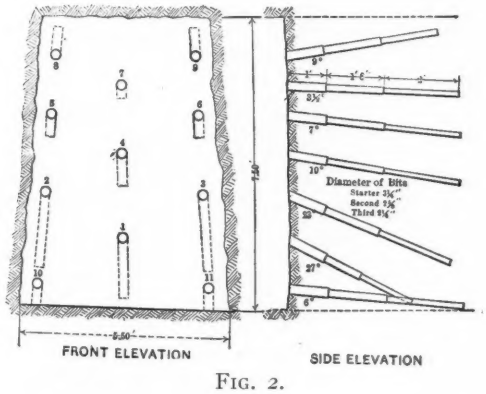


FIG. 2.

TABLE 1.

| | | |

To supplies is charged the cost of picks and shovels. To general expense is charged the wages of foremen and shift bosses, assaying and surveying, pumping, lighting, including candles, office expense and general repairs on the surface.

The air was furnished by a 50-drill, cross-compound, Ingersoll-Sergeant compressor, having steam cylinders 24 & 44x48 in., and air cylinders 22¼ & 38¼x48 in. The air pressure at the receiver was 100 lb. and at the drills 85 lbs. per square inch.

The bore of the large machine cross-cut is 5.5x7.5 ft., that of the small machine is 4.5x7 ft.; it is held that the increase of 1 ft. in width and 0.5 ft. in height of the large machine cross-cut over that of the small machine cross-cut does not facilitate mining operations.

The merits of the work done by the two machines may be briefly stated thus: The use of the small machine saves 25 per cent. of the cost of labor necessary to operate a large machine foot per foot. The cost of operating a small machine is 50 per cent. less than that of operating a large machine, shift for shift. The general tramming-cost of the large machine cross-cut is lessened 20 per cent. by using a small machine. The cost of explosives per foot driven by the large machine can be reduced 37.7 per cent. by the use of the small machine. The cost of hoisting and general expense of the large machine cross-cut is lessened nearly 20 per cent. by using the small machine.

Greater speed, regardless of cost, can be obtained with the large machine, the small machine being from 10 to 20 per cent. slower. The cost of the large machine cross-cut was reduced 27 per cent. by using the small machine.

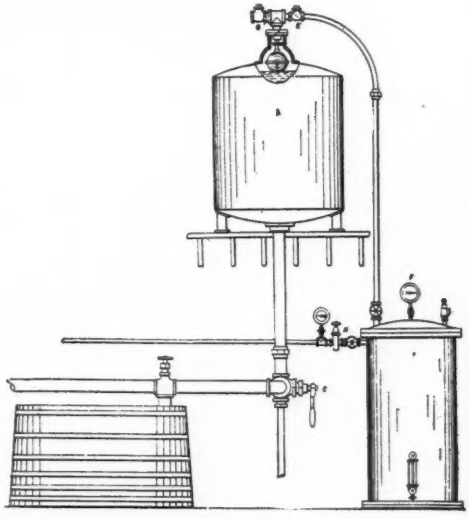
WATER AIR COMPRESSOR

Anton Rehm in *Engineers' Review* describes an original apparatus for compressing air hydraulically. The establishment for which it was designed consumes an average of 25,000 gallons of water per day, drawn from the city mains through a 1½-inch pipe under an average pressure of 60 pounds and discharges into a number of tanks of 1,000 gallons capacity each.

This establishment operates a number of machines requiring compressed air under a pressure of from 2 to 10 pounds. Compressed air is also used for blowing dust out of a number of electric motors.

The illustration shows the compressing device in detail. By placing tank A, having a capacity of 1,000 gallons (or 133 cubic feet) over the water tank room, and a second tank *P*, of 66 cubic feet capacity below the tank *A* in the water tank room and piping them as shown, 3,325 cubic feet of free air will be compressed to about 50 pounds pressure per square inch (which is more than can be used) without the expense of operating an air compressor.

The operation is as follows: Give the handle of the three-way cock *C*, a ⅛ turn, then the water will flow from the water main to the tank *A*, until the float valve closes and in turn

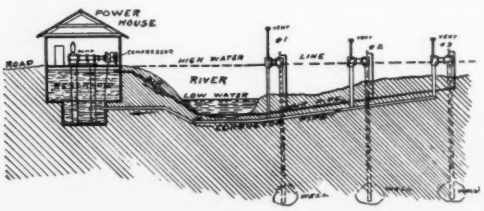


discharges the corresponding volume of air through the check valve *E* into the tank *P*. The gage *F* will indicate about 2 pounds pressure. Then turn the handle of the three-way cock to its original position, when the water will flow from the tank *A*, to the water tank and in turn draw in air through the check valve *G* ready for another filling.

In filling the tank *A* with 1,000 gallons of water 133 cubic feet of free air is compressed in the tank *P* to about 2 pounds and by using 25,000 gallons of water per day it equals 25 fillings or the displacement of 3,325 cubic feet of free air compressed to about 50 pounds pressure per square inch deducting necessary losses. This air is drawn out of the tank *P*, through a reducing valve H, under the desired pressure.

MUNICIPAL PUMPING PLANT AT DES PLAINES, ILL.

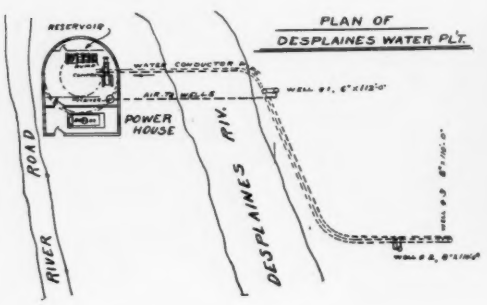
J. Francis Small, in *Municipal Engineering*, describes an interesting air lift plant for municipal water supply. This plant, owing to local conditions, made a departure from general practice as it was necessary to insure against any interruption in its operation throughout the four seasons.



PROFILE DRAWING.

From the profile drawing it will be observed that the reservoir and power house are built together, the walls of the reservoir forming the foundation on which the walls of the power house are placed.

It will be further noted that the reservoir and power house are built on a higher elevation than the level on which the three wells supplying the water are drilled, and that these wells are separated from the power house by the Des Plaines river.



The river is shown at low-water mark, the level at which it flows a good portion of the year. A dotted line indicates a higher level, which is reached in the spring and after heavy rains. When these floods occur the wells become entirely submerged and it would be impossible to pump them if special provision had not been made for so doing.

In lifting water by compressed air it is good practice to discharge the air into the atmosphere and get rid of it as rapidly as possible after it has performed its duty in lifting water from the well.

Where long pipe-runs from wells into a common reservoir are necessary a smaller reservoir or receiving tank is usually provided at each well, into which the water from the well is discharged, and from this tank a

TESTING WELL NO. 1.

conductor pipe is run to the main reservoir.

The illustration herewith will give a clear idea of this system.

On account of the reservoir at Des Plaines being higher than the wells, it became evident that the discharge pipe at each well would re-

TESTING WELL NO. 2.

quire considerable elevation above the surface in order to raise the water to a sufficient height to permit it to run into the reservoir by gravity, after which the question arose as to the building of a separate reservoir at each well in an economical and substantial manner, and provide against the river flowing into them at high-water mark.

The solution of this proposition was to abandon the idea of auxiliary reservoirs and adopt the use of a return pipe at each well. The illustration showing the piping rising from the ground in the form of an inverted "U" will give a clear idea of the method pursued to accomplish this object.

To dispose of the air a vent was provided in the top of the wide sweep "T" forming the top of the pipe riser leading to the conductor pipe. (Note same marked "vent" in profile drawing.) By this form of construction the wells are satisfactorily blown regardless of the river's level and at the same time are closed against interference by the public, yet open to the atmosphere for ventilation.

Prior to the Chicago Pneumatic Tool Company installing its compressed air water lift system the citizens of Des Plaines had no regular supply of water on which to depend, 54,000 gallons being all that could be pumped in twenty-four hours.

The guarantee made by the contractors was to install a plant capable of raising 200,000 gallons of water in twenty-four hours. Under test they raised at the rate of 279,000 gallons for several days.

The outfit consists of one 12x12x14 Type G-S-S Franklin compressor, a 36-inch by 6-foot upright receiver, three Chicago Pneumatic Tool Company's special water lift valves and necessary piping, all of which was furnished and installed by the Chicago company. There are two 8-inch and one 6-inch wells, all three of which are about 110 feet deep.

Bids were submitted by the leading concerns engaged in the installation of compressed air water lift systems, and after due consideration the contract was awarded to the highest bidder.

TESTING WELL NO. 3.

USING PNEUMATIC TOOLS UNDER WATER.

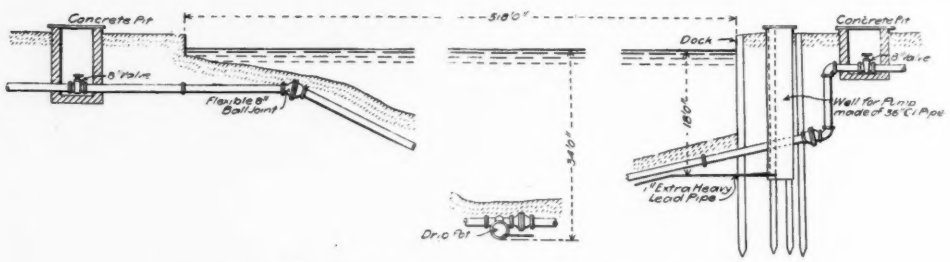
An interesting application of pneumatic caulking tools is described in the April 21st issue of the *Engineering Record.* It relates to the laying of a new gas main by H. M. Byllesby & Co., engineers and contractors, of Chicago, for the Oshkosh Gas Light Co., of Oshkosh, Wis. The main was eight inches in

diameter and was laid under the Fox river from Oshkosh to South Oshkosh during the past summer. It was to replace an old iron main carrying low pressure coal gas. The old main had been badly corroded by the action of acids produced from an unusual quantity of cinders which reached the river. The new main is made of standard cast iron hub and spigot water pipe with lead joints, every three inch joint being a flexible one to facilitate the laying and to permit the main to adjust itself to the bed of the stream. The illustration shows the general layout and the difficulties which had to be overcome. A trench for the main was excavated under the river by a diver using a hydraulic jet supplied with water under 140 lbs. pressure.

The joints between the three 12 ft. lengths of pipe were made upon a scow which was anchored at the point where the work was in progress. A flexible joint was made at the same time on each of the mains composed of three lengths of pipe. The scow was anchored over the position, each section thus assembled was to occupy, and the section lowered into place by a derrick. These sections were supported by chains at two points, one just beyond each of the two joints between the lengths of pipe, in such a manner as to keep them horizontal during the lowering. The flexible joints were of the Falcon ball and socket type with bolted flanged connections fitted with a lead gasket between the flanges. When a section of the main was lowered into place at the bottom of the river the flexible joint on the end next to the pipe already laid was made by the diver. The diver made the lead joints with a pneumatic hammer fitted with a caulking tool. The joints made on the surface were also caulked with the same tool, air power being supplied by a Blake compressor on the scow.

The rock came so close to the surface of the bed of the stream near the middle of the crossing that the pipe had to be anchored to it in order that safety might be insured against displacement. Holes were made in the rock on both sides of the pipe by a pneumatic hand drill, operated by a diver. Expansion bolts were then placed in these holes and strips of iron fastened over the pipe attached to the bolts. After the pipe had been laid, the trench opened with hydraulic jet was soon closed up with silt from the river.

The submerged main was provided with a gate valve at each end on shore in order that it might be cut out of service. A connection with an air compressor was also provided on the river side of one of these valves permitting the main to be tested for leaks. After the laying had been finished, these gate valves were closed and air under pressure of 60 lbs. was turned on to test the joints. Whenever leakage of air occurred a diver went down and recaulked the joints.



Details of Submerged Gas Main Crossing Under Fox River at Oshkosh.

The contractors guaranteed leakage, including condensation, not to exceed four gallons per twenty-four hours. An actual test after the main was completed showed the leakage and condensation to amount to about 2.75 gallons per 24 hours. A hand pump at the bottom of the well on the shore was of sufficient capacity, of course, to remove this quantity of water, the suction lift being reduced to reasonable working limits by the well.

WE are going forward with the greatest load of prosperity ever carried by the American people, and the best thing about it is, that the load is pretty generally distributed, so that we may be spoiled a little, but will hardly break down under it the present year.

BLASTING IN NEW YORK.*

BY R. W. RAYMOND.

The recent numerous instances of damage done to persons and property by blasting within the limits of New York City warrant a more vigilant supervision, not only of the handling of explosives, but also of the methods of excavation involving their use. So far as danger to human life is concerned, it may be sufficient to secure care and competency on the part of those in charge; but with regard to the perpetual nuisance of noise, and the peril in which buildings and foundations are involved, something more should be, and easily can be done. Namely, the unnecessary excessive use of explosives should be prevented. The public now submits to the shocks and dangers of heavy blasts, under the impression that these evils are inevitable. But it is perfectly practicable to make excavations and drive tunnels through rock without such catastrophic performances. In tunneling, for instance, deep holes are usually bored at the face, and heavy charges of explosives are fired in them, with great loss of useful effect, due to the disadvantageous direction of the holes. If a vertical cut were made in the center of the face, small holes on both sides, parallel to the cut, would give with light charges a full theoretical effect, "throwing" toward the center-cut, and wasting neither energy nor noise in pure, useless mischief. The thing has been done. Manufacturers of rock-drills are ready to furnish machines which will make the center-cut; and the process, skilfully directed and manipulated, need not be more expensive in the aggregate than the present orgy of mis-directed power. Even if the direct cost were a little higher, it would be more than compensated by the immunity from expensive accidents. At all events, the citizens of New York have the right to insist that this safe and quiet method shall be absolutely required.

If I am correctly informed, this obvious improvement, while it has shown itself to be both practicable and capable of reasonably economical application, has encountered a passive resistance, shown in lack of loyal co-operation, on the part of contractors and workmen. Engineers do not like to quarrel with contractors over points not definitely fixed by specifications; contractors do not like to quarrel with labor-unions; and labor-unions fight, on general principles, all novelties or economies which do not actually increase wages. So there we are; nothing will move all parties but a legal requirement.

This trouble about the excessive use of explosives is an old story to colliery engineers. The persistent demand of the miners' unions, East and West, that they shall be allowed to waste, as dust, all the coal they choose, and be paid for it as if it were merchantable coal, has been disguised under various plausible forms. But, under all these forms, it means simply that without regard to danger of "dust-explosions," loss to operators, or injury to property, the union miner shall be allowed to use unlimited amounts of explosives, if he can thereby obtain more remuneration for equal pains or equal remuneration at less pains.

Whatever may be conceded in rural districts, the real estate of New York City is too valuable to be fooled with in this fashion.

* Engineering and Mining Journal.

COST OF FUEL FOR ENGINES.

It will be convenient in estimating the amount of coal for hoisting engines and the like, to use the following figures: Allow one-third of a ton of coal for each 10 H. P. per 10-hour shift. This rule holds good for most engines up to 80 horsepower.

In addressing the Glasgow University Engineering Society recently the president, G. T. Beilby, said that there are in Great Britain steam engines and boilers with a yearly output of at least 5,000,000 H. P. The coal consumed by these is not less than five pounds per indicated horsepower, or, on the whole 40,000,000 tons. By the use of gas engines and steam turbines the coal consumption might be reduced to one and one-half pounds per indicated horsepower hour, or, on the whole, to 12,000,000 tons. The saving in coal, therefore, would be equal to 28,000,000 tons, valued at £9,800,000. The cost of making the change need not exceed £50,000,000, or, if the power is to be delivered as electricity, £60,000,000, or respectively £250,000,000 and £300,000,00. Theoretical economies of this kind, he added, were often disregarded; but in the present instance they would amount to over 16 per cent. on the capital expenditure, and still more would result if one takes credit for more efficient plant reducing working costs.

COMPRESSED AIR

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TUNNELING UNDER DIFFICULTIES.

A great deal has been said in the newspapers of late about the difficulties encountered in the tunnels now under way across the East and North rivers about New York. It is not generally understood that there are being constructed at the present time thirteen distinct tunnels under these rivers. Some of them are of large diameter to accommodate railway trains and others of less diameter for rapid transit and trolley service. That tunnels may be built successfully under these rivers is not an open question because it has been done before. The East River gas tunnel was built several years ago and during its construction practically the same difficulties now met with were then encountered and overcome. In the case of the East River the material is not uniform, some of the time rock being encountered, at others mud and sand, and in some places both rock and mud; that is, part of the tunnel may be through rock and the other part through mud. In the case of the Hudson River the problem of construction is more simple because there is mud throughout and this is the reason why we hear less about trouble in the North River than on the other side. Some thirty years ago Colonel Haskin started to tunnel the North River and before his death he succeeded in building a tunnel about three-quarters of the way across. Fourteen years ago this Haskin tunnel was being constructed by Messrs. Pearson, the contractors who are now building the East River tunnels for the Pennsylvania Railroad. The man in charge of this work for Pearsons was Mr. E. W. Moir, who is now the Director of the East River work. The old Haskin tunnel was recently taken up under the able direction of Mr. Charles M. Jacobs, the engineer who had completed the East River gas tunnel, and it is through Mr. Jacobs' able management that the difficulties in the old Haskin tunnel were overcome and the two headings were joined. We have, therefore, behind us the experience of two tunnels completed across both of the rivers and in nearly all of the present work Mr. Jacobs has acted, and still acts, as consulting engineer. In addition to this the Pennsylvania East River tunnels are under the able management of Mr. E. W. Moir who, since his experience with the old Hudson tunnel, has successfully driven the Blackwall tunnel under the Thames at London.

The only real difference between the tunnels now under way and those which have been completed is that the present tunnels are larger in diameter and in some cases are longer. This does not, however, affect the case further than to increase the cost and to make it a little more difficult so far as progress is concerned to drive through material other than rock. Most of the present tunnels are driven at a greater depth than the old tunnels, but this is an element of safety in that they are less liable to "blow-outs." Compressed air, which is the active agent involved, must be supplied at higher pressures than where the work is done nearer the surface, but these pressures have in no case so far exceeded 45 pounds to the square inch, a figure quite safe and considerably below pressures that have been met successfully in caisson work for bridge foundations and such-like. The trouble which the men have experienced from the "bends" or the caisson disease is what must always be expected in work of this kind. Even with the best care and medical attention workmen in compressed air will at times get the "bends" and in some cases the result is fatal. The work about New York is provided with all the safeguards usually employed in work of this kind. In fact the emergency hospitals and the medical examinations are rather more thorough than usual and it is a matter of note that the supply of compressed air per man at work is larger than in any other work of this kind.

There is, therefore, no occasion for alarm about the difficulties incurred in subaqueous tunneling about New York and there is every reason to believe that these tunnels will be constructed within a reasonable time and with as little loss of life and injury to the men as is possible under such extraordinary conditions.

BLASTING IN NEW YORK.

Everything that Dr. Raymond, the distinguished mining engineer, says on any subject is interesting. We publish in this issue a recent editorial of his, entitled "Blasting in New York City," which calls attention in a lucid and practical manner to the reckless disregard of the safety of property and lives in New York City by blasting methods which have always been used and are now used in the mountains. What is safe in a tunnel driven through the Andes should not apply to work done under foundations of buildings in districts where people live and move and have their being. Tunnel driving has grown to be a question of progress; that is, men try to drive fast regardless of shock and of the quantity of powder used. It is a well-known fact that the so-called "cut" holes in the heading of the tunnel are in America put in 8, 10 and 12 feet deep, filled with dynamite and "blown out" in order to release the cut for blasting the side rounds. As Dr. Raymond says, it is perfectly practicable to make rock excavations and to drive tunnels through rock without producing violent shocks. In fact it is a reasonable statement to make that in the centers of population and underneath buildings, or near foundations, the law should prohibit blasting of rock except in cases where there is a free face alongside of every hole that is blasted. Experts know very well that in bench work less powder is used for the same amount of rock removed and less shock encountered than in heading work. This is because bench work always has a free face or a line of least resistance toward which the blast acts, while in heading driving there is no such line until the center cut has been blasted. It is while blasting this center cut that most of the shock occurs. Machines have been designed and put into practical use which make channels in headings or other placing in the rock just as channels are cut in marble and other quarries. These machines are extremely simple and may be operated by common drill runners. The channels may be cut in almost any position and should be placed where they can best relieve the shock of the blast. As a matter of fact channels might be cut so as to enable the rock to be removed without any blasting. This is done in marble quarries but a reasonable and intelligent amount of blasting made in connection with a proper placing of channels should serve the purpose and enable contractors to remove rock at little, if any, increased cost beyond the present system. The saving in explosives is enormous, and when the men are properly trained and the system has been established, there is no reason to expect greater cost or less progress.

CAISSON DISEASE.

There has been much discussion lately about the numerous cases of caisson disease, or "bends" as it is more commonly called, that have occurred. This disease has been the cause of numerous deaths in the East River Tunnels, now being constructed by the Pennsylvania Railroad and has always been considered a mystery and very little has been known of its cause and effect outside of the fact that it usually attacks workmen who had spent too short a time in the air lock. It has been known, however, that frequently cases of "bends" could be cured by recompressing the patient and then allowing the air pressure to be lowered very gradually to atmosphere.

The New York *Evening Post* recently printed a most interesting editorial on the subject of caisson disease, which is of sufficient importance to be reprinted in full, and we regret that space prohibits us from doing this. The *Post* states that recent autopsies performed upon human beings killed by this disease indicate that the "bends" is caused by air bubbles in the blood, as those bubbles have been found in the heart, blood vessels, and various tissues and organs. Air bubbles may seem very harmless and it may be asked how they are capable of producing such profound disturbances and often death. The realization of the serious consequences of air in the circulating blood is as old as Galen. And the danger of allowing air to enter certain veins in the course of surgical operations is guarded against by modern surgeons. If by any chance air as a bubble—that is, in contrast to absorbed or dissolved air—is in the circulating blood stream, it acts like a foreign body. The bubble may pass along for a distance, but at some point it will block the circulation of the blood by obstructing a small artery. Should the air bubble lodge in a vessel of the brain through which the blood passes to nourish some important center, as that which controls respiration, then the brain center would at once cease to function. The individual stops breathing and death ensues. The same is true of an air embolus in the heart. But if the circulation to centers that are not vital is impeded, the other symptoms of the disease are manifested, pains in the limbs and joints and various degrees of paralysis. In the less severe forms of "bends", complete recovery of health is not unusual, because in the course of a little time the air is reabsorbed into the tissue fluids, and those parts which have suffered as a result of starvation in having the blood stream cut off from them are again restored to normal. Only in the case of the nervous system, where regeneration of injured tissue is especially difficult, do permanent injuries result.

If the man who has been in a caisson for several hours under a pressure of two or more atmospheres passes quickly through the decompression lock—so quickly that the air is not held in solution in the blood, but escapes in bubbles in the tissues—this free air causes, if not death, a train of severe and dangerous symptoms. Physicians have been somewhat slow in accepting the explanation of "bends," probably because the facts seem more tangible to a physicist than to one trained to medicine, and also because the observation of cases in the hospital has revealed little in explanation of the disease and nothing as to means of treatment. In fact, "bends" is a condition which need almost never occur.

Leonard Hill and Macleod, two physiologists of the London Hospital, have repeatedly placed monkeys in a small caisson and subjected them to a pressure of eight atmospheres (117.6 lbs. per square inch) without any apparent injury to the animals. These investigators, however, allowed two hours for decompression from this high pressure, which is much more than is ordinarily used in any engineering construction. It is the belief at present that at least fifteen minutes for each atmosphere of pressure should be taken in order to be within the bounds of safety, but whether this precaution will ever be rigidly observed is questionable; and it would be safe to say that the men themselves, as much as any construction company, would object to a period of a half hour spent in a decompression lock, when there is a possibility that no harm would come if only five minutes were allowed for the operation.

A practical milking machine has been installed on the dairy farm of C. F. Moulton & Son, at Cuba, N. Y., where 24 cows are now successfully milked twice each day by the new apparatus. A combination of the vacuum and compressed air systems is used.

USES OF COMPRESSED AIR.

There is no doubt that there is a much greater future for the use of compressed air for all kinds of industrial purposes than is at present appreciated, and that, as a means of transmitting power over long distances with the use of a reheater at the point of consumption, it offers scope for useful experiment and investigation. The utility of compressed air is not appreciated in this country to the extent that it is in others. We associate its use principally in connection with railway brakes and rock drills. In other countries its use is general for all kinds of industrial work, driving engines, locomotives, conveying parcels through tubes, and in Paris this form of power is distributed not only to factories and electric lighting stations, but is sold, like electricity or gas, to householders and restaurant keepers, etc., for all manner of domestic purposes. We referred a short time ago to the successful application of compressed air for several pumping installations by Messrs. Isler & Co., and in a recent issue of COMPRESSED AIR is given an instance of the success and economy of the air-lift in the field of deep-well pumping as compared with pumps of ordinary design. Two belt-driven pumps, with cranks and piston, giving a double-acting effect with a definite length of stroke, were installed. They were driven by an ordinary portable steam engine and boiler; the compressor used was a second-hand "straight-line" machine of 18-inch stroke. The test was conducted by a well-known consulting engineer, who was employed to make tests to determine which system should be installed. The tests were very thoroughly made, and definitely showed that while the deep well pump raised sixty gallons of water per pound of coal burned under the boiler, the air lift, under the same conditions, raised 300 gallons per pound of coal burned. While it is admitted that a much higher efficiency could have been secured for the pump by the use of an economical steam engine, it must be remembered that the use ot a Corliss compound compressor would have given far better results in the case of the air lift.

CHARLES E. TRIPLER.

Mr. Charles E. Tripler, of liquid air fame, died June 20th, at Liberty, N. Y., from Bright's disease, after an illness of two months. The death of Mr. Tripler will remind a great many persons of the remarkable experiments which he conducted and of the extravagant hopes which his work aroused. Up to a certain point the methods of all who have tried to liquify gases have been practically identical, the first step being to compress the gas to a high pressure and the next to remove by a suitable use of cold water the heat developed in that operation. This, however, was not sufficient for the liquefaction of air and various methods were resorted to to reduce the temperature of the compressed air below the liquefying point. Sir James Dewar was accustomed twelve or fifteen years ago to surround the receptacles containing the compressed air with liquid nitrous oxide or ethylene, or something else which is normally a gas. By the evaporation of this substance a degree of cold was produced intense enough to liquefy the contents of the vessel. Such a process was expensive and adapted only to making liquid air in very small quantities. It was Mr. Tripler's ambition to evolve a process by which liquid air might be made on a commercial basis and at low cost. He utilized the expansion of a part of his compressed air to chill the rest of it. His process was, therefore, simpler and less expensive than Dewar's, though not altogether original. It had been employed previously by Linde, in Germany, and by Hampson, in England. Mr. Tripler probably improved the apparatus required and he gave liquid air itself a wonderful impetus in this country.

Mr. Tripler was born in New York City in 1849. His education was received largely from private tutors and, even in his youth, he was interested in laboratory experiments in physics and chemistry. He also devoted much of his time to art, and a collection of twenty of his paintings exhibited in various parts of the country twenty years ago attracted much attention. As soon as his process for liquefying air had been perfected he organized the Tripler Liquid Air Company, capitalized under the laws of Arizona, for $20,000,000. While this company was not a success, it is due to Mr. Tripler to add that while he was sadly mistaken in some of his beliefs, they were honestly held. The reason for his failure was doubtless the fact that he lacked the scientific training necessary to a perception of the fallacies of his own reasoning. This is evidenced by the fact that for a long time he fancied that with machinery driven by liquid air he could

manufacture eight or ten gallons with an expenditure of only one.

While liquid air has not as yet been used to advantage commercially there is a chance that it may result in a cheaper process for the manufacture of oxygen than any other, owing to the fact that nitrogen is slightly more volatile than the other gas with which it is associated in the atmosphere. When the compound has been liquefied the nitrogen shows a disposition to evaporate first. How fully this propensity can be utilized in the manufacture of oxygen is yet to be determined, but it illustrates that though liquid air has been a disappointment in a great many ways it is still likely to prove of some practical value.

NEW PUBLICATIONS.

The Northwest Mining Journal.—A monthly magazine devoted to mining and metallurgy. Edited by James B. Adair. Volume 1, No. 4, April, 1906; paper 6¼x12¼; 20 pages illustrated; $2.00 per year.

This journal receives contributions from a considerable number of special contributors and contains articles of value and interest. It covers the Northwest mining field and makes a specialty of news from Alaska, British Columbia, Idaho, Montana, Oregon, Washington and Yukon. The leading articles in the April issue contain among others, "Opening Up of Claims," by A. J. Colquhoun, E. M.; "Tin Deposits of York Region, Alaska," by J. H. Hill, E. M.; "Placer Mining," by Julian A. Becker; "Pyrite," by Judson C. Hubbart, E. M.; "Gold Mining as an Investment," by George K. Rogers. The more important articles are well illustrated and should be of value to the mining engineer.

TRADE PUBLICATIONS.

Chicago Pneumatic Tool Co.—Circular No. 56, illustrating and describing special electrical tools and accessories, such as air cooled, Duntley electric drills, portable grinders, portable pressure blower, etc. The circular also describes Little Giant pneumatic drills, with Corliss valve, Boyer and Keller hammers, etc., etc., etc.

Ingersoll-Rand Co.—Catalog No. D43, illustrating and describing Rand Rock drills and mountings. Catalog No. X136, on Imperial Type 11 power driven air compressors. Bulletin No. 2007, on Imperial piston air drills. Booklet 6A, devoted to Imperial chipping hammers, Haeseler axial valve riveting hammers, Imperial riveting hammers, rotary drills, motor hoists and "Little Jap" and "Little Imp" plug drillers.

Sullivan Machinery Co.—Bulletin No. 51C, devoted to descriptions of the Sullivan "plug" drill for quarrying and contracting work.

C. A. Burton Machinery Co., Northwest Corner of 2nd and Main Sts., Kansas City, Mo.—"Burton's Water Works for Country Homes."

De La Vergne Machine Co., foot East 138th St., New York City.—Ten-page folder, describing the Koerting four cycle gas engine and suction producer as installed in municipal lighting plants, factories and other places.

York Manufacturing Co., York, Pa.—Twenty-four-page catalog, illustrating and describing York vertical single acting ice and refrigerating machines.

Vilter Manufacturing Co., Milwaukee, Wis.—Catolog A, May, 1906. Refrigerating and ice-making machinery.

The Duff Manufacturing Co., Allegheny, Pa.—Sixteen-page catalog, devoted to a description of the Duff ratchet screw jacks, roller bearing and cone bearing; also differential screw jacks. Eight-page booklet describing the Barrett pipe forcing jack for forcing or pulling pipe horizontally under ground.

De La Vergne Machine Co., Ft. of East 138th St., New York City.—Catalog No. 7, devoted to refrigerating and ice-making machinery.

Great Lakes Eng. Works, Detroit, Mich.—Catalog B, devoted to ice making and refregerating machinery.

A very interesting booklet has been issued by the Goldschmidt Thermit Co., 43 Exchange Place, New York, on the subject of thermit and what may be done with it. "Thermit" is a mixture in powdered form of iron oxide and finely divided aluminum. It melts, or liquefies, within thirty seconds after ignition, forming pure iron and slag, in superheated liquid form, and is an ideal substance for welding steel or iron. Slag has the property of instantly hardening upon contact with cooler surfaces and forms a glaze or skin that is quite refractory even to the intensely hot thermit steel. Upon this fact is based the "thermit" process of welding pipes. The liquid steel quickly brings the pipe ends

to welding heat and a turn of the cranking screws, used in the process, firmly butt-welds the ends of the pipe. Because of the absence of gaskets and packing, welded pipe is especially valuable for ammonia, brine, steam and compressed air piping; it is also suitable for high pressure water pipes. It will be seen that by this process leakage is made an impossibility and this should be a considerable item in large compressed air plants where leakage, although, perhaps, but a small percentage of the total volume of compressed air used, still amounts to a considerable item when figured as power lost. Rods and bars may be welded by this process equally as well as piping or rails, and it can be done on the ground or in the engine room or almost anywhere, in fact, by means of the simple thermit apparatus described in the booklet mentioned above.

THE Gravity Measuring Coal Chute Co., Richmond, Va., is distributing a pamphlet, well illustrated with half-tones and line drawings, descriptive of coal chutes for locomotives. The delivery pockets are in pairs, each pair containing two or four tons of coal. Pneumatic vertical gates control the filling of the pockets from the storage pockets above. It is claimed that this method lowers the cost of coaling locomotives and allows of a reliable record being kept of the amount delivered to each engine as the pockets measure the coal as accurately as it can be measured by volume.

"Producers and Consumers" is the title of the second document of the Congressional campaign of 1906, issued by the American Protective Tariff League. The pamphlet is a reproduction of the great speech of Hon. Leslie M. Shaw, Secretary of the Treasury, recently delivered at St. Louis. Send postal card request for free copy. Ask for Document No. 85. Address W. F. Wakeman, Secretary, 339 Broadway, New York.

As a "cushioning" device and buffer in rock-drilling the back spring plate cannot be beaten in the views of some experts. It is claimed that there are 50 per cent. less side rods broken on this type of machine than on any other. The breaking of a side rod in itself is a small matter, but the loss of time often incurred by the man in going in search of one is of considerable importance.—*Engineering and Mining Journal.*

INDUSTRIAL.

LUBRICATION OF AIR COMPRESSORS.

The high temperatures and general conditions peculiar to air compressions makes the subject of lubrication with graphite an interesting one to all makers and users of such engines.

As far as is known, from statistics gathered by experts, ignitions and explosions in air compressors are due, primarily, to the character and quantity of lubricant used.

The best cylinder oil available is liable to give off explosive vapor, or "carbonize" and clog discharge valves, so that it must be used very sparingly and with caution.

Soap-suds is sometimes used but owing to lack of "body" large quantities are needed and care must be taken to feed oil into the cylinder when the engine is stopped, or rust will form while the engine is not running. In the use of graphite, however, these difficulties are entirely absent. Graphite is, first of all, the best solid lubricant known to science and practice, is absolutely inert, unaffected by high temperatures and cannot vaporize, ignite, or cause explosion.

It puts an unctuous gloss on surfaces where there is friction, it lowers friction, effectively prevents rust and greatly increases the effective power.

Recognizing these many advantages and the superiority of graphite, combined with a lubricating liquid, over all other methods of air compressor lubrication, the Comstock Engine Company have perfected an air compressor lubricator for feeding graphite and soap-suds, or graphite and oil. It is also designed to feed any liquid lubricant without the graphite.

The process is very simple and efficient. The graphite mixed with the oil settles in a compact mass at the bottom of the graphite cup. This mass is in such condition that the oil will not percolate through it, but is caused to flow over the surface of the graphite, a portion of which is carried so that each drop contains the right proportion that is necessary for lubrication.

The graphite may also be fed by using a mixture of graphite and soft soap in the lower cup, and water, instead of oil, in the upper cup, so that the use of oil may be reduced to a

minimum or wholly abandoned. The soap used in this mixture is prepared especially for this purpose contains no uncombined oil or grease, and is a fine lubricant by itself. The "Graphoil" lubricator is as simple as the "Graphoil" process.

It has a cup for the oil or water, having a valve for regulating the flow, and an opening in the cover for filling, and a brass cup beneath for the graphite.

There is also a valve for entirely shutting off all communication with the air cylinder when desired, and provision is made for equalizing the pressure in the lubricator, so that the flow from the cup is uninterrupted under any variation of pressure in the cylinder. This method of using graphite commends itself to users of air compressors as a first class lubri cant at extremely low cost, with the danger of explosion eliminated.

A TRENCH GUARD AND LANTERN HOLDER.

A simple device invented by Mr. D. F. McCarthy, of Waterbury, Conn., is shown in the accompanying cut. It is an ordinary trident made of malleable and wrought iron, 4 ft. 2 in. in length and pointed at the lower end so that it may be driven into the ground. The section remaining above ground, say 2 or 2½ ft., is shaped into three prongs. Where a street is torn up or where there is danger to passers-by, two of these rails are driven into the ground and a board is supported between them, each end fitting into the V-shaped heads of the rails. There is also a device at the top of the prongs to which a lantern may be attached by an ordinary padlock.

The advantages of this device over the old method of building a heap of stones or making a barrier with boards and barrels are numerous. The guard rails are easily driven into the ground, they can be used over and over again, the lanterns are securely locked and there is no danger of their being stolen, this fact alone doing away with one of the causes of damage suits resulting from accidents. Where desired it is possible to build a fence of any length by using several rails. The Manufacturers' Distributing Co., of New York City, are sole agents for the McCarthy rail for the United States.

AN IMPORTANT DECISION IN RECENT PNEUMATIC TOOL LITIGATION.

An important decision was, on May 28th, rendered in London, Eng., in the Chancery division of the High Court of Justice. The suit was that of the Consolidated Pneumatic Tool Company, Ltd., plaintiff, vs. the Ingersoll-Sergeant Drill Company, and Another, defendants. The hearing was before Mr. Justice Warrington and lasted over a week.

The Consolidated Pneumatic Tool Com-Comprny, Ltd., had brought suit against the Ingersoll-Sergeant Drill Company on alleged infringements of the former's patents on the Boyer Pneumatic hammer. They sought to enjoin the sale of Haeseler Pneumatic Hammers in great Britain.

The decision was rendered in favor of the Ingersoll-Sergeant Drill Company.

DE LA VERGNE REFRIGERATING MACHINES.

The De La Vergne Refrigerating Co., are placing on the market refrigerating machines operating on the ammonia compression-system. The compressors are double acting and are built in three types, vertical with oil injection, vertical without oil injection and horizontal.

In the first type, oil—known as liquid base—is injected into the cylinder during the period of compression for the purpose of cooling, sealing and lubricating the cylinder, piston and piston rod. This oil absorbs much of the heat of compression and, therefore, economizes the power necessary to operate the machine. A thin layer of oil on top of the piston and one on the lower end of the cylinder takes up all the clearance space and forces the compressed gas completely out of the cylinder before the suction stroke begins.

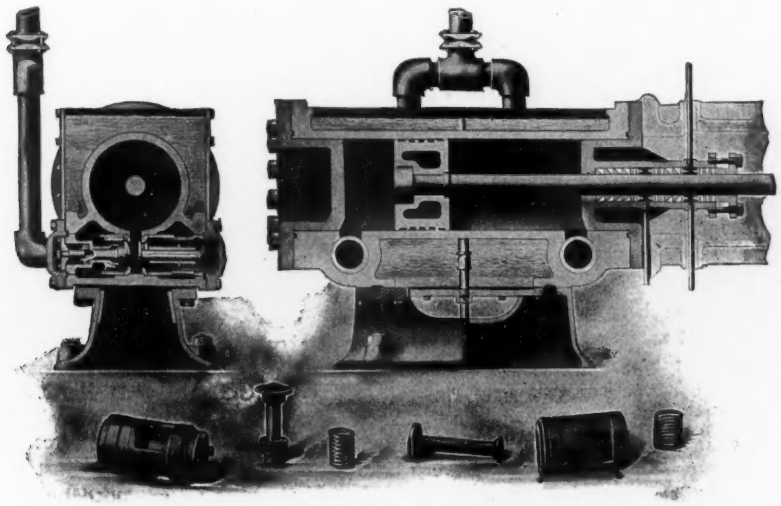
In the vertical compressor with and without oil injection practically the same general design of valves and housings is used. A special feature of these compressors, and one which every engineer will appreciate is the ease with

which the valves can be removed for inspection and cleaning.

The guides carrying the suction valves and springs are screwed radially into cylindrical suction valve housings ground into radial recesses in the main cylinder casting. In order to inspect the valves it is only necessary to remove the valve bonnets, after which the housings can be drawn out with the facility of a Corliss engine valve. The top discharge valves are set in a single large housing which makes a ground joint with the main cylinder casting and is held in position by the main cylinder head.

One lower discharge valve is set, with its compressor and is kept dry during compression. These, as well as the vertical compressors without oil injection, may also be operated with "wet compression" in which a small amount of liquid ammonia is fed into the cylinder through the suction pipe.

In the horizontal compressors the same attention is paid to the convenient location of the suction and discharge valves, these being located like the valves in a Corliss engine, but are all in the lower side of the cylinder. This arrangement allows the same port to be used for both suction and discharge, and in this way the extremes of temperature to which the valves are exposed are equalized.



SECTIONAL VIEW OF DE LA VERGNE COMPRESSOR.

housing, radially into the main cylinder casting. All the valves are held against their seats by springs. Both valves and springs are made as light as practicable, the valves being hollow so that they will offer little resistance to the incoming and outgoing gas.

Heavy valves held in place by stiff springs tend to reduce the back (suction) pressure in the cylinder below that in the suction line and to increase the discharge pressure in the cylinder above that in the condenser, thus diminishing the efficiency of the machine.

The horizontal ammonia compressor is fitted with a water jacket for use with what is known as "dry compression" or that in which ammonia gas is superheated on entering the

The applications of refrigerating machinery have increased to such an extent and have become so varied that refrigeration now forms a complete branch of engineering by itself and no one style of machine can possibly meet all the demands of modern cooling installations.

The De La Vergne Machine Company builds a number of different styles of machines. Among these are steam driven and belt driven machines, each class being built with one or two ammonia compressors. The steam driven machines are built vertical or horizontal, simple, tandem compound and cross-compound, depending on the capacity and space for the installation.

A NEW COLD AIR MACHINE.

A new cold air machine has recently been placed on the market by Messrs. T. & W. Cole, Ltd., of Park Road Ironworks, London, E., England.

This machine has many interesting features, among which simplicity, safety and ease of working should be mentioned, and the fact that it produces a dry cold winter atmosphere in a tropical climate without the aid of any chemicals, nothing being required but the power to work it and the small amount of cooling water for circulation.

This machine should not be confused with the cold air machines so much in vogue in the early eighties. Although the cold air system was the first commercially successful form of refrigeration, its rate of progress was barred by the faults displayed by the earlier machines in their inability to get rid of the moisture before the air was expanded, thus causing large quantities of snow, which partly accumulated in the valves of the machine and caused unsatisfactory working, the remainder being discharged into the rooms causing dampness when the temperature rose above freezing point.

These faults have been successfully combated in the present machine, which is capable of extracting all of the mechanically suspended moisture from the compressed air before the same is frozen, thus rendering the product a perfectly dry cold air, devoid of any snow or moisture, and enabling machines of a very small size to be built and successfully operated for the cooling of rooms containing food, or, when used in conjunction with fan ventilators, for cooling living rooms, etc.

By this system, the air, after being compressed and cooled in the compression cylinder, is still further cooled, and particles of moisture separated from it, in its passage through the cooling chamber, and it is afterwards led to a drying chamber, in which it is caused to pass, by a circuitous route, around the intensely cold walls and ribs of the expansion cylinder, and deposit its moisture thereon, in the form of hoar frost, before being admitted to the expansion cylinder, in which it is caused to do work in driving the piston, which is attached to the crank operating the compression cylinder; thereby converting its remaining heat into work, and producing a correspondingly low temperature about 150° F. lower than when it was taken from the outside atmosphere into the compression cylinder.

The importance of thus ridding the air of its moisture while in a compressed state is, that it enables machines to be built of a much smaller size, and it can be successfully operated without any of the old troubles of the passages or rooms becoming blocked with frozen moisture.

The moisture which is extracted from the air in its circuit round the cylinder is automatically drained off at the end of the day's work by suitable drain cocks.

Many of these plants have been built and are working successfully in all parts of the world, and those which are erected in the Argentine, dealing with the excessively humid atmosphere of those parts, are giving great satisfaction in producing perfectly dry cold atmospheres for the various uses to which it is applied.

These compressors are built with both cylinders lying horizontally side by side, or in vertical models as desired, and suitable for stores for keeping of meat and other produce at a low temperature, and for all other purposes for which a refrigerating machine is required.

THE TRAYLOR ENGINEERING CO. IN MEXICO.

Mr. Samuel W. Traylor, President of the Traylor Engineering Co., has just returned to New York after an extended business trip to Mexico. One of the most important results of Mr. Traylor's trip was the conclusion of negotiations by which the firm of Victor M. Braschi & Co., of the City of Mexico, have taken an exclusive agency for the products of the Traylor Engineering Co., in Mexico.

Victor M. Braschi, the head of this firm, is one of the best known mining and metallurgical engineers in Mexico, and the house which he has established is equally noted. Mr. Braschi is a graduate of the Columbia School of Mines, of the Class of 1881. He has had an extensive experience in ore reducing and other branches of his profession, and has in his employ a large corps of first-class engineers, who look after the business of his house in every part of Mexico. Victor M. Braschi & Co., are also the sole representatives in Mexico of the Ingersoll-Rand Co., the A. S. Cam-

eron Steam Pump Works, and the Erie City Iron Works. In adding to their business the representation of the Traylor Engineering Co., they make a connection which is very desirable for both business houses, as well as for their customers. The Mexican house will carry in stock a large line of the products of the Traylor Engineering Co., and will handle no other make of this class of machinery. They will represent the Traylor Engineering Co., fully so that the customers of that Company in Mexico can feel at full liberty to entrust their business to Mr. Braschi and his representatives, with an assurance that it will be handled with skill and fidelity. The Traylor Engineering Co., had in view a large extension of their business into Mexico and other export countries when they chose the site for their new works at Allentown, Pa. This location besides having a general advantage because of its ready supplies of raw and manufactured materials and trunk line railroad connections is particularly advantageous in its situation for export business. Freight from Allentown can be put f. o. b. at the seaboard cheaper than from New York City. Besides making the arrangement mentioned with Victor M. Braschi & Co., Mr. Traylor succeeded in landing several very important orders during his Mexican trip.

REFRIGERATION BY MECHANICAL COMPRESSION OF ANHYDROUS AMMONIA.

It is only of comparatively recent years that the art of Mechanical Refrigeration has been developed through practical improvement, and has come into not only extensive, but almost common use. We will not enter into the history of the early efforts, and description of the processes attempted along these lines, but will state that experience has developed that the most practical method, and the most successful, is by mechanical compression with anhydrous ammonia as the agent.

This system has proved remarkably successful and has virtually supplanted all others, and what were seeming failures originally arose from faults in design and construction of the necessary machinery, the fact having been appreciated all the while that it was the really correct system for lowering of temperature.

The Eclipse Refrigerating Machine for this work is of novel design, and consists of two vertical single-acting compressor pumps driven by a horizontal steam engine, all parts forming one structure.

The compressor pump is so constructed that it perfectly receives and expels the full charge of gas. No other can do more than this while many do less owing to faults in construction and design.

Each pound of dry ammonia gas discharged by the compressor is capable of accomplishing a definite amount of refrigeration and the maximum pounds of gas compressed for the minimum pounds of steam used in the engine of a refrigerating machine is the real index of economy.

The important feature of this machine is the compressor pump.

The compressor pump cylinders, being of vertical style, are relieved from the weight of the moving pistons with the consequent friction, and thus obviating the rapid and unequal wear of the bore and piston heads.

The gas compression is effected on the up stroke, and the space below the piston is subjected only to the low suction pressure of the gas, ranging from 0 to 35 pounds, hence the piston rod stuffing box packings are easily kept tight without undue friction and wear of the piston rod and an important saving of ammonia.

The suction valve of large area, is located in the piston head, and being balanced by a spring, presents no resistance to the gas which flows into the vacant space above the piston on its return stroke, under the pressure and velocity due to evaporating temperatures of the refrigerating system.

A cushioning chamber with a spring assists in closing the suction valve promptly and noiselessly as the up-stroke begins, the imprisoned gas being gradually compressed until it equals the condensing pressure acting upon the discharge valves located in the pump dome, then discharge begins.

The gas parts with more or less of the heat of compression through the walls of the cylinder; the dome and cylinder being enveloped by a water jacket, through which cold water is constantly circulating. This not only prevents superheating of the gas during compression, but also carries off much of the heat, materially assisting the condenser, and cutting

down the gas resistance to a marked degree, below that which would be present without its use.

The safe operation of the piston, metal to metal against the top cylinder head and the expulsion of the full charge of compressed gas without danger, is secured by the movable pump head, of what is termed a safety head, being a valve of the full size of the compressor bore, through the seat of which the piston may pass without injury.

This safety head does not regularly operate as a valve, the working discharge valve being in the centre of the safety head, and fitted with cushioning chamber and spring, securing prompt and noiseless operation.

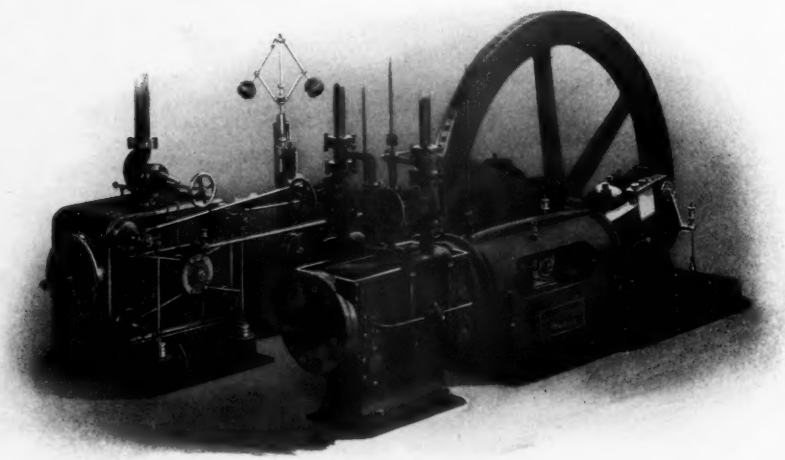
The safety head, with its discharge valve, valve guides and valve seat is self-contained and independent of the pump cylinder, rendering the whole valve mechanism convenient for repairs, removal, or replacing by duplicates without loss of valuable time.

In case of accident to a compressor pump the stop valves on the suction and discharge of the disabled one may be closed and the other pump continue to work, the disabled pump being examined and repaired at leisure.

The proper proportions and sizes of engine to drive a gas compression pump of a given size, under the conditions of its use, as well as the perfecting of such engine that it will do the work with maximum economy in fuel and minimum wear and tear calls for a large experience, to establish the best adaptation.

In this machine, the steam engine is an integral part of the machine, and incorporated in the structure, the construction being such that the engine and pump are self contained.

The engine rod connects directly upon one of the pump crank-pins, and the relative position of engine and compressor is such that a delivery of the power of engine to the pumps is effected during the maximum compression, and in the most perfect manner possible securing economy of transmission; and uniform motion being maintained through the heavy flywheel.



ONE TYPE OF ECLIPSE REFRIGERATING MACHINE.

The wearing and bearing surfaces have adjustments for compensating, and are of the most liberal extent, the main crank shaft being supported in three bearings of rigid stability, and located with best references to the demand of power transmission, shaft alignment, and the avoidance of destructive strains.

In connection with the installation of a first class refrigerating machine for Cold Storage, Abattoir, Packing House, Chemical Works, Brewery, Ice Factory, etc., it will be in order, to secure the highest attainable efficiency, that the Condenser system, Cooler system, Ammonia and Vaporizing systems, Valves, Connections, Tanks and all details of the outfit, be given the most careful consideration of the engineer, and a perfect adaptation made to the

general details of the duty required.

The triple pipe brine cooler is especially adapted for use in cooling the circulating brine to the low temperature required in connection with the operation of freezing systems with storage rooms. In its operation the annular space between the intermediate pipe and inside of the outer pipe, takes the current of warm brine discharged by brine circulating pump and passing thence through the inside pipe of the cooler goes out to the brine delivery pipe system.

The annular space between the inner pipe and inside surface of the intermediate pipe being connected with the ammonia liquid feed and gas returns, secures the rapid and efficient heat transfer and vaporization due to surroundings of rapid brine currents, attains the lowest temperature with the higher economical pressure of return gas. Many of these coolers have been installed with most gratifying success in accomplishment of the results sought for.

The Eclipse Refrigerating machine is manufactured by the Frick Company, Waynesboro, Pa.

AN ENGLISH AIR COMPRESSOR.

A new air compressor is being put on the market by Messrs. Thomas White and Sons, of Paisley, and one is being installed in the new shops of Lilybank Boiler Works, Tollcross. The new machine is of the low speed type, which the makers consider gives the highest efficiency. The example referred to has a steam cylinder 15 inches in diameter and an air cylinder 15¼ inches in diameter, the length of stroke being 24 inches. Working at 100 revolutions, it is capable of compressing about 500 cubic feet of free air per minute. The features of most interest are the air cylinder and the methods of governing. The valves, which are made of nickel steel, are light and are of small diameter, but combined give a large port area. This the makers find gives a higher efficiency than a few valves of large diameter. By a new arrangement the piston passes partly over the valves, so that there is really very little lost space at the end of the stroke, while it is impossible for a valve to drop into the cylinder in the event of it breaking. The valves are all interchangeable, and can be instantly removed by unscrewing a covering brass cap. In the action of the governing arrangements, the inlet pipe closes when the pressure in the receiver rises to 100 pounds, and the compressor then works in a vacuum. At the same time a small piston is operated, acting on a double-beat throttle valve shutting down the steam until the compressor is only just moving. With this arrangement, and with the ordinary high-speed governor on steam end, a double check is effected. The steam cylinder is fitted on the compressor with a Meyer expansion gear, enabling the steam to be cut off at any point from ¾ to ⅞ of the stroke, even while the compressor is running. The White compressor is to be employed for supplying power for pneumatic caulking and drilling tools, of which the new works will have a great number.

PURIFICATION OF COMPRESSED AIR.

In the use of pneumatic tools and the operation of all devices where compressed air is the motive power, there are failures of the apparatus due to the presence of scale, moisture and dirt in the air.

Numerous devices are used for eliminating this objectionable material. Large reservoirs at the air compressors and in some cases at the outlets around the shops are used to give the moisture time to settle. Screens are used which will hold back all particles of dirt that cannot pass through the mesh. Again, in order to clean the air more effectively we find a double screen packed with some fibrous material. This last method makes a very effective device, but accumulated dirt and moisture tends to stop the free flow of air.

A new device for purifying compressed air, the Derby Dust Collector, is now being put on the market by the Derby Manufacturing Co., of Burlington, Iowa. This device is particularly novel in that it uses no screens, but depends on centrifugal action to purify the air. The collector is made in one casting, and has two chambers, an upper separating chamber and a lower collecting chamber. At the bottom is a plug for cleaning. The plug supports a pedestal and cap which holds in the collected material. The air enters the upper chamber at the side, which gives a whirling motion. This action throws the dirt out to the sides of chamber and is drawn down into the lower chamber. The dirt would be drawn up through the vortex of this whirling body of air were it not for the cap which

is placed in the path of this vortex. The purified air at the center of the upper chamber goes out at the top part of casting. This form of collector will purify the air of all material that has a specific gravity heavier than the air. It takes the collected material out of the air path and gives a free passage way for the air at all times. Where there is much moisture accumulating, a petcock is used for more readily draining the collection chamber.

The collector is small and adapted for use at the outlets of air pipes where it will give the maximum efficiency in keeping the dirt and moisture out of the apparatus that is being operated.

In the operation of air brakes on passenger and freight trains it is essential to have the brakes on all cars operate as nearly simultaneously as possible. The accumulation of dirt and moisture in the valves makes this simultaneous operation uncertain. This collector keeps all foreign material from passing from the pipes to triple valve, consequently it increases the efficiency of their operation and decreases the amount of cleaning and repairs.

SCIENCE LIBRARY OF THE PRATT INSTITUTE.

The applied science reference room of the Pratt Institute Free Library (Ryerson street near DeKalb avenue, Brooklyn) has for its object the aiding of those engaged in any trade or industry, irrespective of any connection with Pratt Institute. Hundreds of questions arise every day, in the factories and shops of a city, which could be answered from some printed page. It is the intention of the reference room to supply this need as far as possible, sometimes with books, very often with periodicals or transactions, and again with trade catalogues.

In the room set aside for this work in the Free Library of Pratt Institute are taken nearly a hundred trade and scientific papers, giving the latest news of the industrial world. There are besides over fifty of the labor union papers, of which a file is preserved. The most important of the periodicals are bound, and these bound files contain much material that can be found nowhere else. The publications of the United State Patent Office are kept here also and are used daily. The collection of books includes up-to-date publications in various industries, such as electrical engineering in all its branches, plumbing, manufacture of textiles, industrial chemistry, gas engines, the making of cement, and so forth and so forth. The books in this room are not allowed to go out, so that anyone coming is sure to find the book he wishes to refer to, if it is a part of the collection. The library has, however, a good collection of books in these subjects for circulation, often duplicates of the books in the applied science reference room. The room is in charge of Mr. Edwin M. Jenks, whose work is to help those who are looking up any question that lies within the province of this room.

A large collection of trade catalogues furnishes the very latest information in many lines, and is being enlarged constantly. The library will get any trade catalogue in print, at the request of any user of the library, if it is obtainable. One new feature of the room is a collection of mounted cuts of machines and mechanical devices. These may be used in the room or taken away to work with, if desired. A man looking up a new form of chuck, for example, will find a score of cuts showing different chucks, and among these may well find some that will be of service to him.

Men studying in the evening schools, those preparing for civil service or other examinations, lawyers, and men of various interests, will find this department of use. The room is open every day except Sunday, from 12.30 P. M. to 9.30 P. M., and can be used between 9 A. M. and 12.30 through the library office.

Ores and Metals announces that from this time on it will be published by Reinert Brothers, of Denver, Col. Under the new management the paper has been enlarged and considerably improved both in appearance and in the quality of its contents. Those who know the present publishers have no doubt that the improvement will continue. The new *Ores and Metals* will be edited by Mr. Carl H. Paddock.

The object of piston valves originally was to take the place of large slide valves which could not be made tight and were therefore ineffective. In action the piston valve decreases the friction and increases the port opening for the same space occupied by the valve. A typical shape of a piston valve is a D slide valve wrapped in the form of a cylinder.

PRACTICAL ITEMS for PRACTICAL MEN.

AIR COMPRESSOR GAVE MOIST AIR.

Air compressors, as most engineers know who handle them, sometimes cause a "bunch" of trouble. The plant that I have charge of has been running about two years, and among a lot of first class apparatus a new compresser was installed of the compound type, having cylinders 18 inches in the low side and 12 inches on the high side with a 12-inch stroke, belt-driven.

When I started this compressor everything ran all right, but the air was very moist, sometimes getting so bad that it could not be used on the air hoist in the foundry or on the pneumatic drills in the machine shop, and it was up to the engineer to furnish dry air. The receiving tank would sometimes fill up to ¼ of its capacity with water, and I was wishing that Bill B. Banger was around to help me find the trouble.

One Sunday I took off the heads and found that the high pressure cylinder was full of water, while the low pressure cylinder was dry. I then examined the cooling chamber which is located between the low and high pressure cylinders, and found that full of water also. Then I began to see light.

The trouble was caused by the drain pipe from the cooling chamber being connected into the main drain pipe in the engine room. This main drain pipe received the water from all the pumps, condensers and engine drips in the plant. The compressor was provided with a governor which was placed on the air intake pipe. When the ball on this governor is down the compressor takes air and discharges it until the desired pressure is obtained. Then the ball rises, the intake valve closes and the compressor runs under a high vacuum.

My trouble was that every time the compressor ran under a vacuum, when the valve on the drain pipe on the cooling chamber was open, it drew all the water that was in the drain pipe into the compressor, and from there it found its way into the receiving tank and caused trouble.

I disconnected this pipe from the main drain pipe and the air has since been perfectly dry, excepting in rainy, or real cold weather, when it may get a little moist, but not enough to cause any trouble.

A. B. M., in Engineers' Review.

PRESSURE ANNUNCIATOR.

A new pressure annunciator with which there is said to be no danger of failure to operate the air mechanism properly has just been perfected. The new instrument is guaranteed to warn the operator whenever the air pressure falls below or exceeds certain predetermined standards. The device can be adjusted to the exact low or high air pressure that is desired. When the air pressure drops below the low pressure point previously determined, the annunciator, which is generally installed on the storage pipe line leading to the engineer's brake valve, blows a continuous whistle for 15 seconds. When the air pressure exceeds the high pressure point previously determined, the whistle sounds continuously until the excessive air pressure is reduced to the normal high pressure point. The annunciator also operates as a pop or relief valve, and will discharge to the atmosphere the capacity of the compressor, should the compressor become short-circuited, or if the operator is unable to stop it, thus preventing the burning out of electrical apparatus, or the blowing up of pipe lines or reservoir. It is nine inches in height over all, and two inches in diameter. It will insure an even braking pressure at all times, and can be used upon any airbrake system in operation at the present time.

LEAKY valves in pipe lines are in most cases due to the abuse of the valve. There are a number of ways in which this abuse occurs. When the line is laid cement is improperly used, gets into the pipe and then lodges on the valve seat. Again, the pipe is sometimes threaded longer than is necessary, with the result that it is screwed against the partition of the valve, injuring it. The lighter valves are sometimes sprung by the wrong applicaton of pipe wrenches, while the attempt to strain leaking stuffing boxes, instead of repacking them, is often the cause of much injury to a valve.

THE PNEUMATIC TOOL.

In the old shops—and the lapse of a few years makes things "old" in this progressive age—the machinery was all heavy and stationary. Elaborate and powerful devices were necessary to bring large pieces to the place where alone it was possible to perform some necessary operation. Now, owing to the progress of invention, we move the tool itself about. Often it can be made so small as to be held in the hand, so that the ease and rapidity of work have both been greatly multiplied. This has been due in great part to the introduction of pneumatic transmission. Says Mr. R. Emerson, writing on the subject in *The Engineering Magazine*:

"The great variety of uses to which air power can be put has made its development rapid and extensive and its effect on prevailing practices and methods has been so marked as almost to revolutionize every important line of modern engineering. Stone cutters, rock drillers, motors, hammers, yoke riveters, hoists, lifts, presses, carpet cleaners, sand blasts, painting machines, conveyors, bolt nippers, jam riveters, flue cutters, holder-ons, air jacks, sand rammers, bell ringers, sand sifters, fire forges, brazing and welding flames—these are a few of the less well-known uses of compressed air.

"Pneumatic and electric motors do not 'generate' power; they turn into useful work the energy transformed through them. Both electric and pneumatic motors are of such recent development that many practices that ought to be obsolete still prevail, especially in railway shops, where competition does not exert the same stimulus as in commercial shops.

"The shops of the immediate past had a main shaft driven by a Corliss engine. This shaft drove all the machine tools. There was either a mechanical or a hand crane—or none at all—over the assembling floor. Present practice drives generators direct by high-speed 'automatic' engines; takes the current to large 20 or 30-horsepower motors (relegated to the rafters in the shops), each driving a 'group' of machines, through main and countershafts, some heavy machines having individual motor drive; and also installs an air compressor, reservoir and piping, with motors and hammers for use on the floor and outside.

"While it is probable that individual and group drive will be retained much as at present, the impending advance in shop betterment with increase of capacity, indicates that many heavy operations will be done by portable tools (whether light electric or air, or the heavier electric-driven machines carried on trucks or transferred by crane) avoiding the effort of moving the mountain to Mohammed. It is this phase of the question that interests us, for it means a transformation not only of work done by hand to work done by power, but also transplanting of work done in the machine shop to work done on the floor, and the savings and economies to be effected will be considerably greater than those obtained through individual group electric machine drives— greater even than those obtained by high-speed steels. For example: if it takes 14 hours to set up a job and six to do it, of which during less than three a high-speed tool is actually cutting, a saving of 10 to 12 hours might be realized by moving a portable tool to the part to be repaired or machined.

"A few years ago (and even in some shops to-day) all drilling, tapping, chipping, calking, riveting, reaming, flue rolling, grinding of joints, cutting, beading, valve-seat facing, ramming, etc., was done entirely by hand, and there was no such thing as an air-lift to handle work for heavy machines; to-day all progressive shops are dependent on air for economical production."—*Stove and Hardware Reporter.*

IN working iron bars up into a chain, it is easy to see that the longer each indidiual link, the less will be the number of welds, and the cheaper the resulting chain in first cost It is sometimes claimed that each weld is a source of weakness, and that the chain containing the least number will be the stronger. This is not true, for the longer the link, the greater will become the knuckling action at the ends when going over sheaves and pulleys, and the larger the sheaves must be if the chain is to work upon them without undue wear.

THE following rule is a good method for determining the safe working load of a chain; D = diameter of iron in eighths of an inch; $D^2 \times 0.111$ = safe load in tons. This gives for a ¾-in. chain a working load of $6 \times 6 \times 0.111 = 3.996$ tons.

CHIPPINGS.

FOR removing sand from small brass castings, hydrochloric acid one part and water ten parts makes about the best solution that is used in ordinary practice.

Music is playing an important part in the digging of the Isthmian Canal. Laborers from the West Indies are all accustomed to sing as they work, and bosses who are capable of leading a chorus have much greater success than men who do not have that faculty.—*N. Y. Times.*

With a Central America stage setting, attractively semi-nude natives in the background and the principals dancing a May-pole dance with streamers of red tape, it only needed a dash of music to give the finishing comic opera touch.

It is said that the United Steel Corporation contemplates the installment of air compressors on all of its big steamers. The air compressor has become an important part of all wrecking outfits, since the advent of the steel steamer with a double bottom, and the big steel corporation last fall had several opportunities for the prompt use of compressed air in forcing the water out of the bottom compartment.

The Rix Compressed Air and Drill Company, San Francisco, E. A. Rix, manager, has established itself temporarily in Grass Valley, where arrangements have been made with the Taylor Foundry and Engineering Company to allow the Rix men to work in the shops on both old and new work and on drills. Certain machinery in the Rix shops in San Francisco was destroyed by fire, and is being rebuilt at Grass Valley.

The Traylor Engineering Company has recently received orders for two blast furnaces from clients in the Northwest. The size of these furnaces is 46″ x 255″. They are to be equipped with the Giroux Hot Blast Top which utilizes heat which is usually lost in the ordinary blast furnace practice. The use of this equipment reduces the coke charge ordinarily used from three to six per cent., according to the amount of sulphur in the ore. The company has an order for two other furnaces for British Columbia, 46″ x 204″, and another order for two furnaces for a Mexican Company, each 42″ x 160″, and another for a New Jersey Copper Refinery 42″ x 60″. In fact their works are so completely flooded with work that they are working night and day. Their foundry department is particularly crowded. They are turning out from 30 to 40 tons of castings daily, and as soon as their new addition to the foundry is completed, will have a capacity of 75 tons of castings daily. They expect to have the addition in full operation on or before August 15th.

Now navigation is made more safe by ringing a bell placed under a lightship or lighthouse—the ringing done at will by means of a tube carrying compressed air. The water, being a better conductor of sound than air, carries to a great distance and the ship is fitted with a microphone standing in a closed vessel of water next the keel. A wire from the vessel leads on deck and is connected with a common telephone receiver—the whole giving distinct sounds independent of atmospheric conditions at marvelous distances. Thus the sea as well as the air is made the medium of wireless telegraphy and another great advance is put upon firm foundations promising increasing usefulness.

Compressed air employed as motive power in collieries at a distance from the shaft bottom is theoretically less efficient than electric transmission, on account of the thermodynamic loss of available energy. There is often a large leakage of air in long pipes. One of the chief advantages arising from the employment of compressed air-plants in coal mines is security from dangerous accidents.

—*Inland Operator.*

They don't know anything about *theoretical* efficiencies in coal mines; only *bank* efficiencies count. Compressed air is employed first of all because it pays; second, because nothing else will do its work; third, because it is always to be depended upon; fourth, because there is so little loss in transmission or by leakage; fifth, because the air is a good thing in itself; last, but not least, because it is a preventive rather than a cause of dangerous accidents.

The German Railroad Union offers every four years prizes for improvements in railroad appliances and methods. This year 7,500 marks are offered as first prize, 3,000 as second and 1,500 as third for inventions and improvements affecting the construction and maintenance of the railroads, the same for those affecting rolling stock; and a first prize of 3,000 marks and two prizes of 1,500 marks each for improvements in administration methods, operation and statistics and for publications of notable value. The Union suggests some of the subjects which are felt to need improvement, though the prizes will not be confined to these. Among these suggestions are: Mechanical apparatus for firing locomotives; improvement of steam car-heating apparatus, especially for long trains; hose coupling for air-brakes, in which cut-off cocks may be dispensed with, without affecting the automatic working when trains break in two; apparatus for communication between trainmen and the locomotive, especially for long passenger and freight trains without continuous brakes, and also in passing through tunnels; a critical consideration of the present condition of the motor-car question, and of the running of light trains either by motor-cars or locomotives; simplification of the methods of dividing receipts from freight passing over more than one line, and of other freight accounting. The objects competing must have been put into use (or the writings published) between July 16,

1901, and July 15, 1907. Any such improvement must be in use on some railroad of the Union and be approved by such railroad. The applications for competition must be made between January 1 and July 15, 1907.

At the twenty-first ordinary meeting of the Society of Arts, held recently, Prof. Thomas Oliver, physician at the Royal Infirmary, and professor of physiology at the College of Medicine, Newcastle-on-Tyne, England, read a paper, illustrated by lantern slides, on "Bridge Building by Means of Caissons," with special reference to a modern disease called "compressed air illness."

Describing in detail caissons and the work carried on by their use, the lecturer explained how the compressed air and other conditions affected the workmen, and produced the malady referred to, and in his conclusions he urged the absolute necessity of a shortening of the shifts, and of the length of time spent by the men in the caissons as the air pressure is increased.

Experience, he added, had shown that young men between the ages of 20 and 30, who were temperate, whose tissues were still elastic, men who were of spare rather than of stout build, not only did the work better, but were not so liable to caisson disease.

The London *Tribune* states that the successful use of liquid air as a cooling agent has depended to a great extent on Sir James Dewar's admirable device of vacuum vessels.

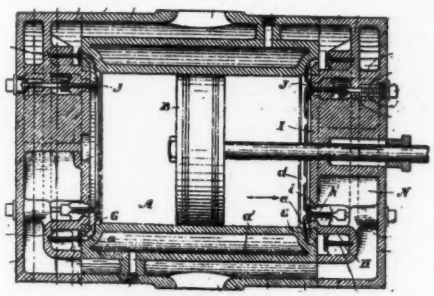
Liquid air boils at about 200 degrees Centigrade below zero. Thus, ordinary surroundings in a room are very hot compared with it, and if this heat is allowed to get access to the liquid air, it will rapidly boil away, and be dissipated. The problem is, therefore, to construct a vessel which shall, as far as possible, prevent conduction of heat to the liquid within. This can in some measure be accomplished by woolen wrappings and by glass vessels with several successive walls. But, as Sir James Dewar showed in the early days of liquid air, a space exhausted of air to the uttermost forms a far better partition than any material substance. Radiant heat can, of course, pass through the best vacuum—and it is well that it can, for otherwise we should receive no heat from the sun. This fact makes the complete heat insulation of liquid air impracticable. But a vacuum partition prevents the passage of heat by conduction, or by air currents, and these are the causes which chiefly contribute to the loss of liquid air when kept in an ordinary vessel. In order to jacket liquid air with a vacuum, it is necessary to put it in a double-walled vessel, all air being pumped out from the space between the walls. Up till recently these double-walled vessels have been made of glass, in the form of two concentric globes, united at the neck, so as to have an air-tight space between them. This space can be exhausted and hermetically sealed. Liquid air can then be kept in the inner globe. Ingenious and useful though these vessels are, their use is attended with considerable inconveniences.

Sir James Dewar has just shown how these objections may be overcome by the use of metal vessels in place of glass ones. This may seem a simple and obvious step, but is not by any means so. The great difficulty in the use of metal is to get a good vacuum in the space between the walls. Almost all metals contain a certain amount of gas locked up in their pores, and this they slowly give out, spoiling the vacuum thereby. None but the very best vacuum is of any use for the purpose, and the extraction of every trace of gas out of the pores of the metal by an air-pump is an interminable process. To overcome this difficulty, Sir James Dewar has made use of the property of charcoal which he discovered—its power of completely absorbing gases at low temperatures. A few fragments of charcoal are placed in the hollow space between the walls of the vessel; as soon as liquid air is poured in, this charcoal gets cooled to a very low temperature, and absorbs any residual gases in the space between the walls. The vacuum soon becomes good, and for preservation of liquid air these vessels are not inferior to the glass ones.

The points in favor of compressed air are: Immunity from danger; simplicity of working; assistance to ventilation. The quantity of air given to aid ventilation, however, is very small as compared with the volume of air needed. In the use of compressed air there is no danger of sparking, or cables being cut, as in electric transmission lines.—*Engineering and Mining Journal.*

821,041. REPAIR-PLUG FOR PNEUMATIC TIRES. RALPH P. KINNEY, Cleveland, Ohio. Filed Oct. 20, 1905. Serial No. 283,586.

821,299. AIR-COMPRESSOR AND THE LIKE. ALPHONSE J. LAVOIE, Toronto, Canada. Filed March 2, 1905. Serial No. 248,075.



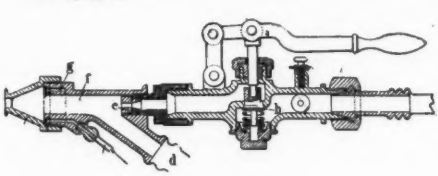
Claim.—1. In a device of the class described, in combination, a cylinder having an open end, an annularly-arranged outlet-port, a water-jacket surrounding said cylinder, and inlet and outlet passages at opposite sides of said water-jacket, said jacket having ingress and egress ports, a head, having a centrally-disposed boss closing said open end, an annular partition surrounding and forming with said boss an annular inlet-port to said cylinder, a vertically-disposed partition forming with the annular partition-chambers to register with said passages, and annular inlet and outlet valves mounted in said head as and for the purpose specified.

821,325. BEARING FOR ROCK-DRILLS. THOMAS E. ADAMS, Cleveland, Ohio. Filed June 7, 1905. Serial No. 264,132.

821,399. HOISTING-CRANE. MILFORD F. BERRY, Fay, N. Y. Filed Dec. 23, 1904. Serial No. 238,132.

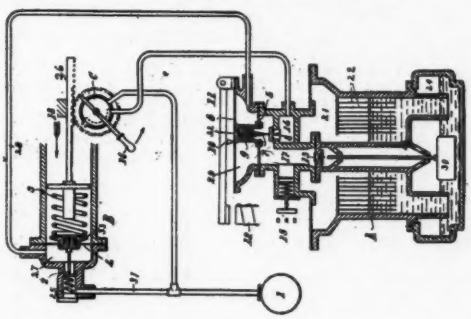
Claim.—In a crane, a mast having a lower pivot, an upper socket member secured to the mast, a pivot-rod extending within said socket member and provided with bifurcated arms, a support for receiving the ends of said arms, guiding-sheaves mounted on the bifurcated arms, a crane-arm also having guiding-sheaves, a hoisting-cable guided by the several sheaves, a stationary operating-cylinder, a piston disposed in said cylinder, a piston-rod, and means for connecting the cable to the piston-rod.

821,415. SAND-BLAST MACHINE. CHARLES A. P. HESS, Paris, France. Filed Feb. 10, 1904. Serial No. 192,928.



Claim.—1. In a sand-blasting machine, a mixing-chamber divided by a longitudinal partition into two compartments, a projecting nozzle secured to the chamber and provided with a partition in alinement with the partition of the chamber, and means for forcing air and sand into the compartments of said chamber.

821,418. AUTOMATICALLY-REGULATED LIQUID RHEOSTAT OPERATED BY MEANS OF COMPRESSED AIR. COLOMAN DE KANDO, Budapest, Austria-Hungary, assignor to Railway Electric Power Company, a Corporation of Maine. Filed Nov. 27, 1903. Serial No. 182,700.



Claim.—1. A liquid rheostat combined with a supply of compressed air, a throttle-valve between said compressed-air supply and said rheostat adapted to control the supply of compressed air to the rheostat; said valve being controlled by the combined action of the electric current flowing through said rheostat and compressed-air pressure.

821,524. PNEUMATIC CONCRETE STEEL CAR-BUMPER. THOMAS MCCORMICK, Somerville, Mass. Filed Dec. 11, 1905. Serial No. 291,353.

821,563. GAS-PUMP. RICHARD WHITAKER, New Brunswick, N. J., assignor, by direct and mesne assignments, to Brunswick Refrigerating Company, a Corporation of New Jersey. Original application filed Jan. 11, 1904. Serial No. 188,612. Divided and this application filed Jan. 5, 1905. Serial No. 239,723.

821,568. PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS. FREDERICK W. WOOD, Kansas City, Mo. Filed June 13, 1905. Serial No. 265,111.

821,574. FLUID-PRESSURE REGULATOR. ALEXANDER ANDREWS, Carbondale, Ill. Filed Aug. 3, 1905. Serial No. 272,564.

821,584. PNEUMATIC STACKER AND STACKER ATTACHMENTS FOR THRESHING MACHINES. SAMUEL D. FELSING, Crookston, Minn., assignor to The Indiana Manufacturing Company, Indianapolis, Ind., a Corporation of West Virginia. Filed Aug. 15, 1904. Serial No. 220,788.

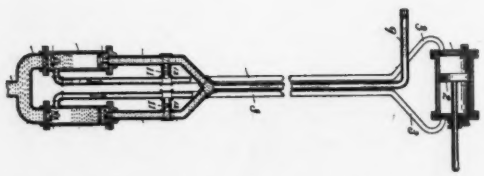
Claim.—1. In pneumatic stacker attachments for threshing-machines, the combination with the stacker-frame and with the fan, hopper and delivery-chute mounted thereon, of means for connecting the stacker-frame to threshers, said connecting means being adjustable in accordance with the different widths of the threshers, substantially as described.

821,663. FLUID-PRESSURE CYLINDER. THOMAS J. MITCHELL, Connellsville, Pa. Filed Sept. 13, 1902. Serial No. 123,357.

821,672. AUTOMATIC CONTROLLER FOR MOTOR-COMPRESSORS. WALTER J. RICHARDS, Milwaukee, Wis. Filed March 9, 1904. Serial No. 197,317.

821,677. LIQUID-IMPELLING APPARTATUS. DANVILLE W. STARRETT, Oakland, Cal. Filed June 12, 1903. Renewed Nov. 20, 1905. Serial No. 288,273.

Claim.—In a liquid-impelling apparatus, a receiver, a check-valve admitting the liquid to the receiver, a liquid-discharge pipe from the receiver, a check-valve between them, a compressed-air pipe having separate communications with the receiver and with the liquid-



discharge pipe, and means for producing alternately positive and negative pressures in the compressed-air pipe, substantially as described.

821,706. ELASTIC-FLUID TURBINE. CHARLES G. CURTIS, New York, N. Y., assignor, by mesne assignments, to General Electric Company, a Corporation of New York. Filed May 14, 1903. Serial No. 157,067.

821,722. STRIKING-BAG OR OTHER FLUID-RECEPTACLE. CLARENCE A. LINDSAY, New York, N. Y. Filed June 24, 1905. Serial No. 266,834.

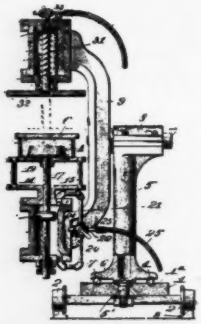
821,747. CONTROLLING APPARATUS. WALTER J. RICHARDS, Milwaukee, Wis. Filed July 2, 1903. Serial No. 164,085.

Claim.—In combination, an electric motor, a fluid-pump driven thereby, a pressure system supplied by said pump, switching means controlled by the pressure in said system to govern the circuit for said motor, and electrical means for preventing the operation of the suction-valve of said pump upon the closure of the circuit through said motor.

821,758. VALVE. FRANK L. SMITH, Chicago, Ill., assignor of two-thirds to Alva C. Ricksecker and one-third to Lewis A. Nichols, Chicago, Ill. Filed July 18, 1904. Serial No. 216,935.

821,776. MEANS FOR REMOVING DUST. CARL F. W. ZOELLER, Altona-Ottensen, Germany, assignor to The Firm of Alfred Gutmann Actien Gesellschaft für Maschinenbau, Altona-Ottensen, Germany. Filed June 28, 1905. Serial No. 267,420.

821,791. MOLDING-MACHINE. WILLIAM M. DUNCAN, Alton, Ill. Filed March 13, 1905. Serial No. 249,886.



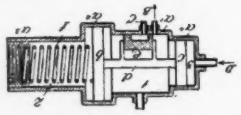
821,806. PNEUMATIC SURF-BOARD. ALBERT S. JOHNSTON, Los Angeles, Cal. Filed May 19, 1905. Serial No. 261,206.

821,858. PNEUMATIC TIRE. HANS L. CHRISTIANSEN, Boston, Mass., assignor of one-third to Harald Tidemand and one-third to Ole Worm Dahl, Boston, Mass. Filed May 24, 1905. Serial No. 261,933.

821,859. AUTOMATIC AIR-BRAKE CONTROLLER. THOMAS CLEGG, Winnipeg, Canada, assignor of one-third to Alexander McKinny and one-third to Robert Andrew Bonnar, Winnipeg, Canada. Filed Nov. 20, 1905. Serial No. 288,285.

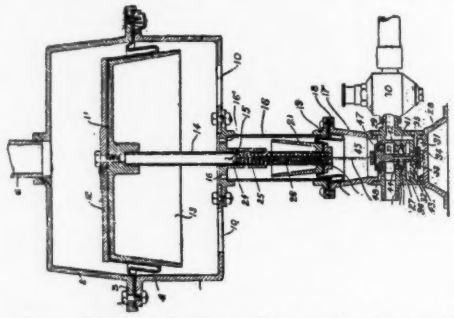
Claim.—In an automatic air-brake controller, a cylindrical casing having threaded ends and an intermediate contracted portion providing an interior annular shoulder, a valve-seat resting against said shoulder and having a beveled inner face, and a spring-pressed valve having a correspondingly-beveled edge and a by-pass, substantially as described.

821,870. REGULATOR FOR AIR-PUMPS. WILHELM HILDEBRAND, Gross-Lichterfelde, near Berlin, Germany. Filed June 6, 1905. Serial No. 263,964.



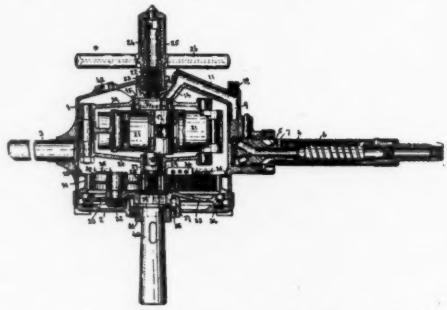
821,917. PNEUMATIC ACTION FOR PIANOS. ALFRED ANDERSON, Chicago, Ill. Filed Aug. 24, 1904. Serial No. 221,941.

821,926. AIR-COMPRESSOR. HARRY B. CORNISH, Minneapolis, Minn., assignor of two-thirds to P. Peterson, Glenwood, Minn. Filed Feb. 2, 1905. Serial No. 243,799.



Claim.—The combination, with a casing having intake and exhaust ports arranged one above another and intake and exhaust valves, said intake-valve being normally open and said exhaust-valve closed, and said valves having a rod or stem, of a diaphragm within said casing above said valves and having an opening to receive said rod, means interposed between said diaphragm and the upper free end of said rod for raising said rod to close said intake-valve and open the exhaust, and a spring put under tension by the initial movement of said diaphragm to aid in seating said intake-valve, substantially as described.

821,960. PNEUMATIC-MOTOR TOOL-STOCK. FREDERICK W. PARSONS, Tarrytown, N. Y. Filed Jan. 7, 1905. Serial No. 240,013.

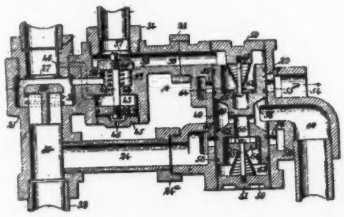


Claim.—In a pneumatic-motor tool-stock, the combination of a casing having a motor secured to one of its heads, admission and exhaust passages leading

from the motor through the head and down the shell of the casing to a chambered boss formed thereon, a throttle-valve in said chamber, a sleeve through which air is admitted to the valve, said sleeve acting as one of the handles of the tool-stock, and means on said sleeve for shifting the valve to shut off or change the direction of flow through the said passages.

822,021. TIRE FOR VEHICLES AND THE PROCESS OF MAKING THE SAME. Thomas C. Sanderson, West New Brighton, N. Y. Filed July 14, 1905. Serial No. 269,574.

822,073. AIR-BRAKE SYSTEM. Arthur I. Perry, New York, N. Y. Filed May 26, 1905. Serial No. 262,363.



Claim.—In an air-brake system, the combination with a supply-pipe and a controlling-pipe, of a source of pressure connected with the supply-pipe, primary and secondary controlling-valves connected with the supply-pipe and controlling-pipe, said secondary controlling-valve comprising a piston-valve which may be simultaneously subjected to the influence of the pressure in the supply and controlling pipes and check-valves for closing the supply-pipe and controlling-pipe, and a brake-cylinder communicating with the secondary controlling-valve.

822,146. PNEUMATIC HAMMER. Edward C. Meissner, St. Louis, Mo., assignor, by mesne assignments, to Chicago Pneumatic Tool Company, a Corporation of New Jersey. Filed Nov. 12, 1900. Serial No. 36,212.

Claim.—A pneumatic hammer comprising a cylinder having ports for the admission and escape of air, a piston in said cylinder, and a valve for controlling the admission and release of air, said cylinder having a supplemental exhaust-port located in the forward portion thereof in position to be uncovered by the piston shortly after the initiation of its return movement and before the completion of such return movement, substantially as described.

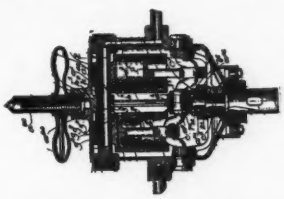
822,220. MACHINE FOR BLOWING HOLLOW GLASS ARTICLES. Cornelius J. Nolan, Toledo, Ohio. Filed Oct. 29, 1904. Serial No. 230,566.

Claim.—In a glass-blowing machine, the combination of an air-conduit leading to the article to be blown, of an air-valve in said conduit, and means for opening and closing the same to admit a limited quantity of air, and means for subsequently opening the valve for blowing purposes, for the purpose described.

822,223. AUTOMATIC CONTROLLER FOR PRESSURE SYSTEMS. Walter J. Richards, Milwaukee, Wis. Original application filed March 9, 1904. Serial No. 197,317. Divided and this application filed April 6, 1905. Serial No. 254,256.

822,367. PNEUMATIC DRILL. Adelbert P. Hanscom, Malden, Mass. Filed Aug. 27, 1903. Serial No. 170,893.

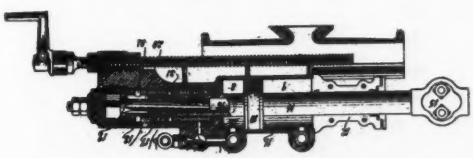
Claim.—In apparatus of the class described, a casing, an arbor rotatably mounted in and extended through one end thereof, a pair of oscillating cylinders each having a piston, a combined trunnion and valve structure supported within the casing and on which the cylinders are mounted side by side, at their ends, two separate crank-shafts operatively connected with the pistons and mounted in alinement, a pinion on each crank-shaft, and a gear operatively connected with the arbor and with which said pinions mesh at diametrically opposite points.



822,520. AIR-BRAKE. Ed A. Graves, Randolph, N. Y. Filed Feb. 8, 1906. Serial No. 300,193.

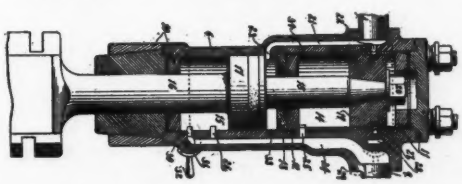
Claim.—The combination with train pipes or hose having coacting couplings upon their adjacent ends, of stop-cocks or valves arranged in said pipes, operating elements upon said valves, and a connection between one of said pipes and the operating element of the valve in the other, substantially as described.

822,596. ROCK-DRILL. Arthur H. Gibson, Easton, Pa., assignor to Ingersoll-Rand Company, New York, N. Y., a Corporation of New Jersey. Filed Dec. 21, 1905. Serial No. 292,756.



Claim.—A tool-piston having a front rod and a tail-rod, a cylinder having a tail-rod chamber, pipes for feeding motive fluid alternately to the opposite sides of the piston and a single means for bringing the tail-rod chamber into open communication with one of said pipes or the atmosphere at pleasure.

822,597. CHANNELING-MACHINE. Arthur H. Gibson, Easton, Pa., assignor to Ingersoll-Rand Company, New York, N. Y., a Corporation of New Jersey. Filed Feb. 14, 1906. Serial No. 301,013.

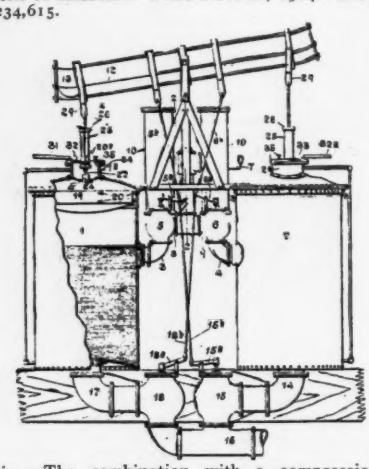


Claim.—A tool-cylinder having piston-chambers therein, a piston having heads in said chambers, air-feeding tubes, said cylinder having front and back ports for the two chambers communicating with their respective tubes, and an auxiliary back port for one chamber communicating with the tube other than the one with which the other back port communicates and a valve for opening and closing said auxiliary back port.

822,645. AIR-GUN. Walter R. Benjamin, Granite City, Ill. Filed Aug. 24, 1905. Serial No. 275,582.

822,689. AIR-COMPRESSOR. Bryan Obear, St. Louis, Mo., assignor to Montague Compressed Air Company of Missouri, St. Louis, Mo., a Corpora-

tion of Missouri. Filed Nov. 28, 1904. Serial No. 234,615.



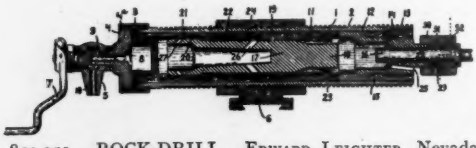
Claim.—The combination with a compression-tank and valve controlling the admission to and exhaust therefrom of the motive fluid, of a float in the tank, a piston connected to the controlling-valves, and a weighted valve in the path of movement of the float and arranged to first engage and initially lift the piston and afterward admit beneath the same compressed air from the tank; substantially as described.

822,747. AIR-BRAKE. GEORGE E. MARCH, Muskegon Heights, Mich., assignor of one-half to Lawrence G. Sweningston, Muskegon, Mich. Filed April 20, 1905. Serial No. 256,573.

823,023. AIR-BRAKE APPARATUS. HENRY F. BICKEL, Plainfield, N. J., assignor to New York Air Brake Company, a Corporation of New Jersey. Filed Nov. 6, 1905. Serial No. 286,098.

Claim.—The combination with an automatic air-brake apparatus; of means responsive to flow of air into the train-pipe in the release operation for delaying the discharge of air from the brake-cylinder of one of the brake equipments, substantially as described.

823,048. AIR-BRAKE. JOHN P. KELLY, Watertown, N. Y., assignor to New York Air Brake Company, a Corporation of New York. Filed Feb. 12, 1904. Serial No. 193,279.



823,059. ROCK-DRILL. EDWARD LEICHTER, Nevada City, Cal., assignor of one-fourth to John Bender, Hamilton, Ohio, and one-fourth to J. C. Campbell, Nevada City, Cal. Filed May 20, 1905. Serial No. 261,294.

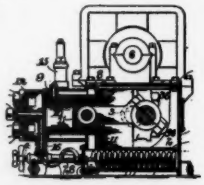
Claim.—In a rock-drill, the combination, substantially as set forth, of a shell, means for turning and advancing said shell, a cylinder within the shell, a fluid-actuated piston reciprocating within the cylinder, a chuck-body separably disposed within the forward end of the shell and having a chambered portion within the shell, and a bushing secured in the forward end of the shell and serving to retain the chuck-body therein.

823,060. COMPOUND FLUID-PRESSURE MOTOR. JOSEPH P. MAGNEY and WILLIAM H. MASTERMAN, Los Angeles, Cal., Frederick R. Kellogg administrator of said Masterman, deceased, assignors to National Engine Company, Los Angeles, Cal., a Corporation of Arizona. Filed Aug. 1, 1905. Serial No. 272,162.

823,105. PRESSURE-ACTUATED VALVE-GEAR. WILLIAM H. COLLIER, Jackson, Tenn. Filed March 31, 1904. Serial No. 201,023.

823,114. TRAIN SIGNALING SYSTEM. JOSEPH GERARD, Gainesville, Tex. Filed July 31, 1903. Serial No. 167,792.

823,156. FLUID-COMPRESSOR. NIELS A. CHRISTENSEN, Milwaukee, Wis. Original application filed Sept. 9, 1899. Serial No. 729,957. Divided and this application filed Dec. 11, 1899. Serial No. 739,900.

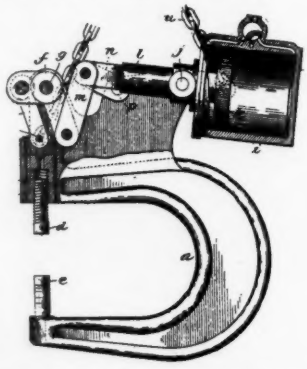


Claim.—A compressor comprising a casing, a plurality of cylinders therein having pistons, such casing having a false bottom forming a cooling-chamber integral with said casing and each of said cylinders having independent and valve-governed suction and discharge passages, a series of independently-removable covers for said chambers provided with passages for the inlet and exit of the fluid under pressure, and independent cooling-coils located in said cooling-chamber and connected at their ends with said passages in the removable covers.

823,185. AIR-VALVE FOR GAS-ENGINES. REUBEN MILLER, JR., Pittsburg, Pa., assignor of one-half to D. W. Dunlevy, Pittsburg, Pa. Filed Jan. 27, 1905. Serial No. 242,945.

823,210. TURBINE-MOTOR. NATHAN W. FLETCHER, Chicago Heights, Ill., assignor to Turbine Motor Tool Company, Chicago, Ill., a Corporation of Illinois. Filed April 27, 1904. Serial No. 205,098.

823,273. FLUID-PRESSURE RIVETING-MACHINE. ELMER E. HANNA, Chicago, Ill. Filed May 15, 1903. Serial No. 157,234.



Claim.—In a riveting-machine, the combination with a supporting-frame having a sliding plunger therein, of means for moving said plunger at a relatively rapid and gradually-decreasing speed and for continuing the final movement at a substantially uniform speed and maximum pressure, said means including a main lever fulcrumed in the frame above the plunger, a link connection between one end of said lever and the plunger, a link pivoted to the frame, a link connection between said link and the opposite end of said lever, and means for moving the link pivoted to the frame about its pivot.

823,274. FLUID-PRESSURE RIVETING-MACHINE. ELMER E. HANNA, Chicago, Ill. Filed May 15, 1903. Renewed April 25, 1906. Serial No. 313,680.

823,278. PNEUMATIC ECONOMIZER AND AIR-INJECTOR. EDMUND HOXIE, Everett, Mass. Filed Dec. 17, 1904. Serial No. 237,259.

Claim.—An air-injector, comprising a plurality of units arranged in tandem, means for passing air under pressure successively from one unit to the next in series and each unit of said series having also an independent connection with the air-supply for increasing the speed of the air already in motion, and an inwardly-opening check-valve for the unit or units beyond the first unit.

Office CHIT-CHAT

COMPRESSED AIR, New York.

GENTLEMEN:—I have the letter of your Mr. Hulbert and beg to thank you for the attention shown my recent inquiries. I have heard from two people already, and am very anxious to hear from Prof. Lucke.

FIRST COPY OF YOUR MAGAZINE RECEIVED AND I HAVE HAD MY MONEY'S WORTH IF I NEVER RECEIVE ANOTHER COPY.

I enclose list of some of our principal operators. Every one uses compressed air and should have your valuable magazine. Write them and send sample copy. Use my name if you wish.

Very truly yours,

————————, Pres.
The —— Mining and Development Co.

¶ When we receive letters such as this we naturally expand with a justifiable and joyful pride, and, to be quite truthful, we have been expanding very frequently of late.

¶ We realize, however, how dangerous it is to let expansion get the mastery, as a too rapid and overwhelming enlargement might very easily extend to the capital regions and cause plain swelling of the head.

¶ Which would mean such over-confidence in the worth and merit of COMPRESSED AIR that the reading pages would be allowed to deteriorate with a balancing booming of the advertising pages, a condition which would be equivalent to driving a team of horses and economizing by denying them oats and water.

¶ We refuse to be flattered out of our sense of proportion. We refuse to be stroked and patted so hard that we lose our balance. We do not mean for one moment that we don't enjoy being told how good the paper is—nor do we mean to imply that Mr. ——— letter is EMPTY flattery—the trouble that he has taken in giving us a long list of possible subscribers precludes the intimation—but we do mean that words of encouragement will be received, joyfully received and accepted with gratitude and used only as a spur to further us to better deeds.

¶ The advertising pages continue to show a healthy and material growth, and we may be partially excused for pointing a happy finger each month at the little table below, showing just how new advertising has come in. Since the May issue of COMPRESSED AIR the following concerns have put their O. K. on the magazine by stretching their appropriations in order to include us in their advertising plan:

Bury Compressor Co.	¼ page
Peter A. Frasse & Co.	¼ page
Hanna Engineering Works	¼ page
Sprague Electric Co.	½ page
Traylor Engineering Co.	1 page
Sargent Steam Meter Co.	¼ page
A. E. Hoermann	¼ page
Wm. Powell Co.	⅛ page
Comstock Engine Co.	¼ page
Cleveland Pneumatic Tool Co.....	¼ page
Total	3⅜ pages.

FLEXIBLE STEEL-ARMORED HOSE

OUR Flexible Steel-Armored Hose has demonstrated its superiority over all other types or makes of protected hose. The steel armor entirely encases the rubber tubing and thoroughly protects it from external injury even on the sharpest bend. It also acts as a bandage in case the rubber lining becomes damaged from over vulcanization and thus prevents the loss of steam or air and permits the drill or other machine to be kept in use until it is convenient to replace the damaged part with a new piece.

When a piece of hose is damaged in one or two places, don't throw it away. Cut out the damaged part and unite the good pieces by means of our splicing clamp. It will save money.

WRITE FOR COPY OF PAMPHLET No. 50646

Sprague Electric Company

General Offices:

527 West 34th Street, New York City

Engineering-Contracting

THIS is a weekly journal, edited by HALBERT P. GILLETTE, author of Handbook of Cost Data, Earthwork and Its Cost, Rock Excavation, etc. The articles in ENGINEERING-CONTRACTING form a sequel to Mr. Gillette's books, being, for the most part, articles on the methods and costs of doing work. In addition to these articles, the contract news of the week is given. This news service is believed to be superior in point of promptness and accuracy to the news in any other engineering or contracting paper. Mr. C. T. Murray, who has been in charge of the contract news department of Engineering News until last December, is now in charge of our contract news department. Mr. Gillette, who has written for other papers in the past, including Engineering News, will write only for the ENGINEERING-CONTRACTING hereafter. His series of articles on Cost Keeping on Contract Work, now running, should be read by every contractor and engineer.

The Subscription Price of Engineering-Contracting is only $1.00 a year. Send for a sample copy.

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ATTORNEYS-AT-LAW

WASHINGTON, D. C.

220 BROADWAY. NEW YORK

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Powell Air Gun Valve?

Blows your work bench, machine tool, in fact everything perfectly clean. Operation is another case of "Press The Button." Order a sample.

THE WM. POWELL CO., Cincinnati, Ohio.

AIR LIFT PLANTS

For Pumping Deep Wells.

Advantages of the Air Lift System.

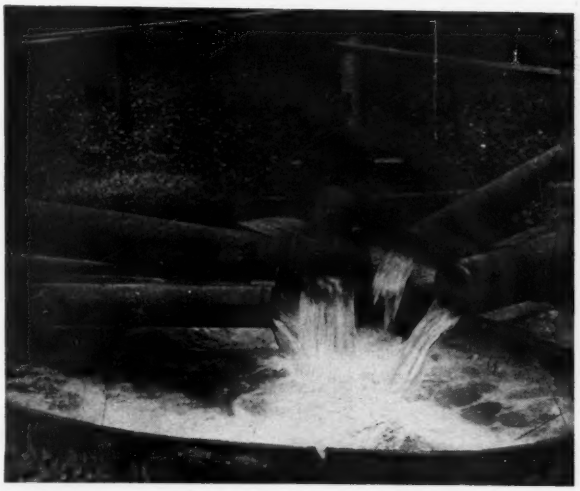
Low cost of wells and equipment, owing to the simplicity of the apparatus.

Low maintenance charges, due to the absence of working parts exposed to wear.

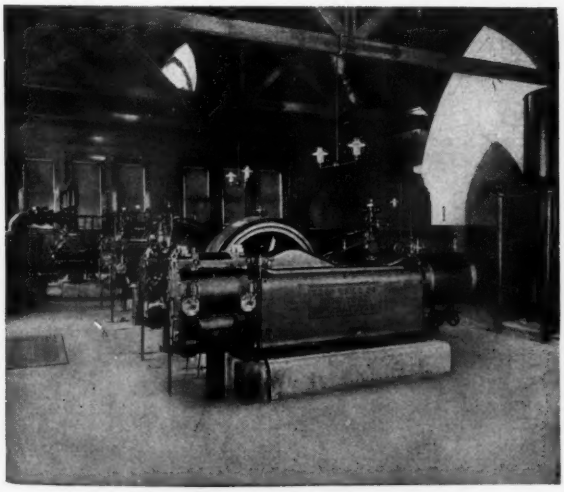
A maximum flow from any well, arising from the absence of any obstructions in the water passage.

Wells may be scattered over a large water-bearing area, yet all may be pumped from one central compressor plant.

Each well separately and independently controlled.



Air Lift Installation at Houston, Tex. Six Wells Operated from Central Air Plant.



Ingersoll-Rand "Imperial" Air Compressor Operating on Air Lift Plant at Riverside Ill.

Air Compressors. Air Tools.

INGERSOLL-RAND CO.,

11 Broadway, NEW YORK.

Chicago	Cleveland	El Paso
St. Louis	Pittsburg	Boston
Philadelphia		Houghton, Mich.

U 42

The Slogan of the Cameron: "Character: the Grandest Thing."

CAMERON PUMPS

IN SUBWAY AND TUNNEL CONSTRUCTION.

Over 100 Cameron pumps are in daily service and many are being operated continuously during the 24 hours of each day, in the 14 subaqueous tunnels entering New York.

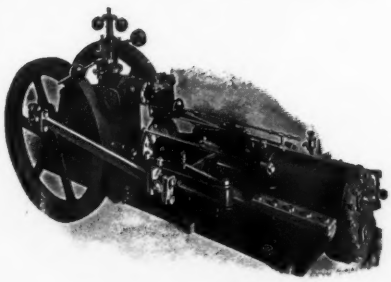
Because they are of simple, yet superior design, best material and construction. And the most durable, effective, reliable and economical in cost of maintenance of any pumps on the market.

Underground View in one of the tubes now in course of construction under the East River by S. Pearson & Son, and showing a No. 9 Cameron Pump. Size 12 x 7 x 13. Normal capacity 200 gallons a minute, or double in an emergency.

We will send our Catalog "K" on request, or will be pleased to confer with you in person.

A. S. Cameron Steam Pump Works

Foot of East 23d Street, New York.



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EMBODYING LATEST IMPROVEMENTS

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McKIERNAN DRILL CO.

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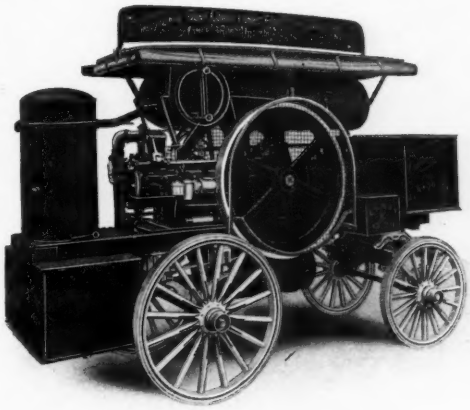
House Cleaning Machinery

Stationary Private Plants for residences, **$350** and up. Power from lighting current.

Private Plants for Department Stores, Hotels, Theatres, etc.

Stationary Plants for Professional Carpet Cleaners.

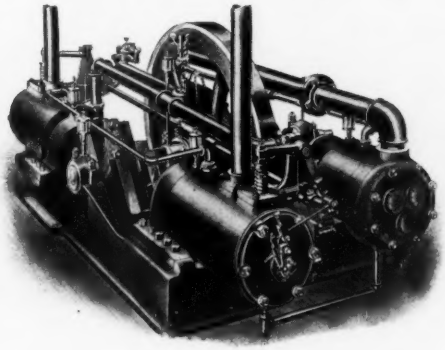


Portable Plants for residential house cleaning. Small capital required.

General Compressed Air House Cleaning Co.

4434 Olive Street, St. Louis, Mo.

Direct-Connected Gasoline Air Compressor



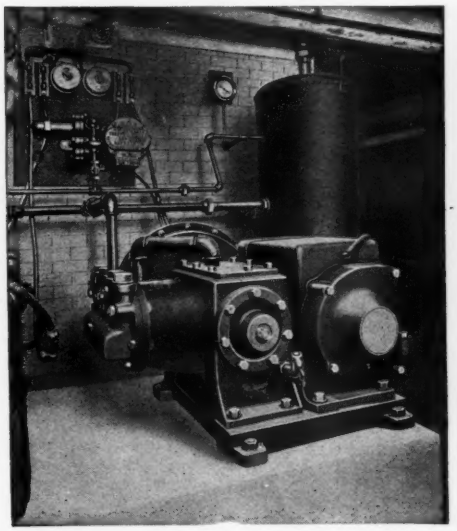
Single, double and four cylinder types.

Built in all capacities for all purposes. GEARLESS, COMPACT, ECONOMICAL and DURABLE. Furnishes its own power. The only machine of its kind.

We also manufacture electrical and belt-driven Air Compressors, Gas and Gasoline Engines, Spraying, Pumping and White Washing Machinery.

In asking prices and specifications on any class of machinery, please give full information as to requirements.

GENERAL ENGINEERING CO.,
4435 Olive Street, St. Louis, Mo.



Westinghouse Motor Driven Air Compressor, Operating Sewage System, Knickerbocker Trust Building, New York.

Westinghouse Air Compressors

Westinghouse Traction Brake Co.

General Offices : Pittsburg, Pa.

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Chicago, 1545 Ry. Exch. Bldg.	New York, 2014 Trinity Bldg.
Cincinnati, 1111 Traction Bldg.	Richmond, 804 American Nat. Bk. Bldg.
Cleveland, 1007 New Eng. Bldg.	St. Louis, 1932 North Broadway.
Columbus, 1132 C. Sv. & Tr. Bldg	St. Paul, 634 Endicott Bldg.
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For Canada, Canadian Westinghouse Co., Ltd., Hamilton, Ont.

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APPARATUS

For Cleaning Castings, Structural Steel and Stone Work, etc.

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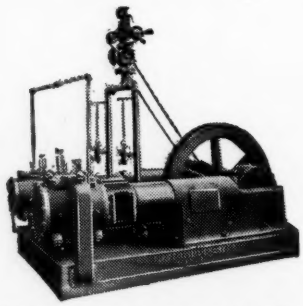

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THE BLAISDELL

Air Compressors

Possess distinctively original features of

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Not found in other makes.

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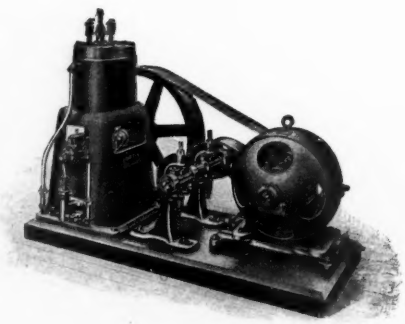

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AIR COMPRESSORS

CURTIS & CO. MFG. CO., St. Louis, Mo.

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LIST OF AGENTS:

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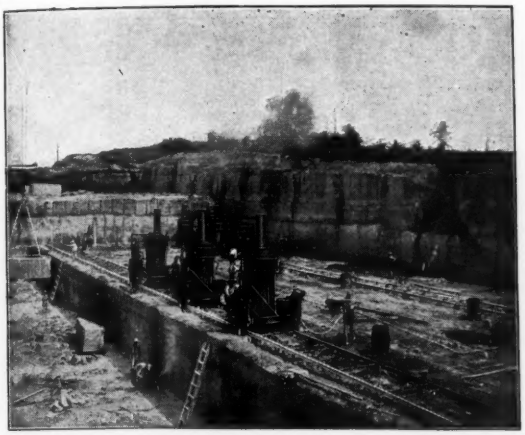
Baird Machinery Co., Pittsburgh, Pa.
Hill, Clarke & Co., Boston, Mass.

STONE CHANNELERS

For Rock Excavation in Quarries and Contract Work.



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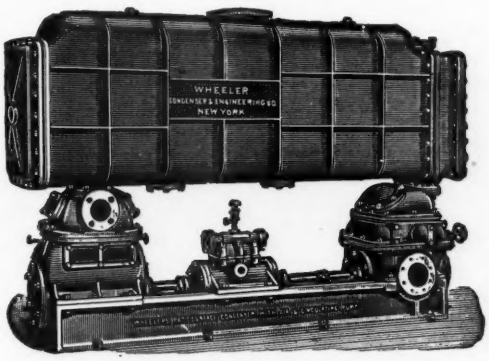

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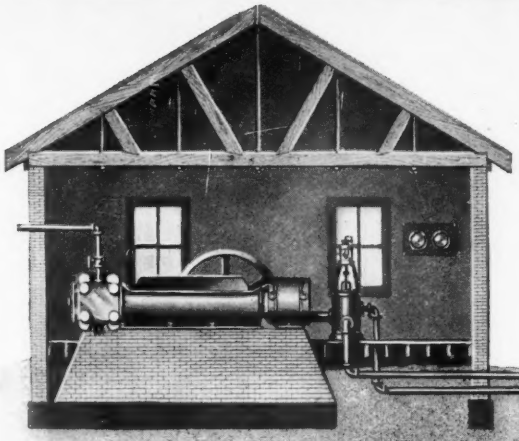

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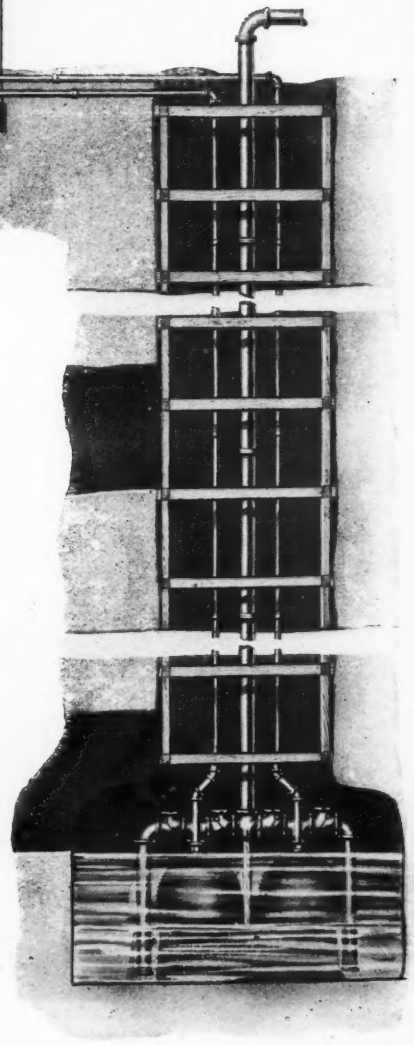

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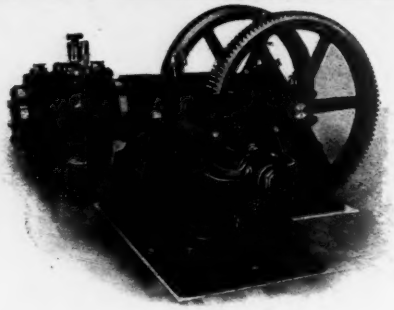

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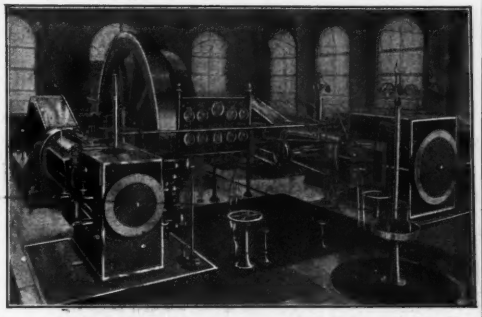

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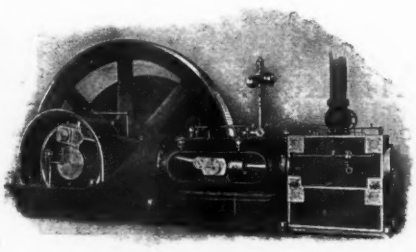

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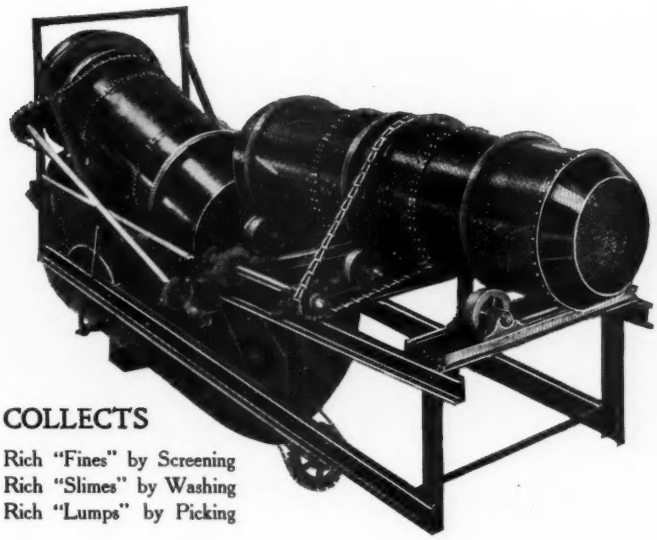

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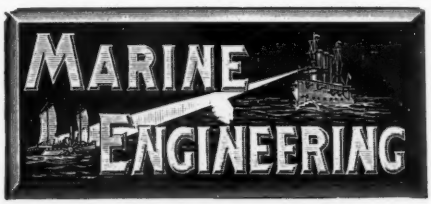

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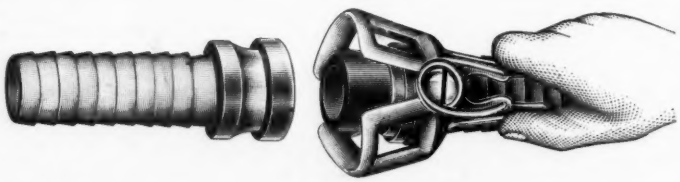

Universally approved by Mining and Engineering Companies, Railroad and other Machine Shops, Bridge Companies, Etc.
Clean or gritty, they OPERATE INSTANTLY; they stand the PRESSURE and THEY SWIVEL.
They are made with or without attached releasing levers.

The W. J. CLARK CO., 35 Depot Street, SALEM, OHIO.